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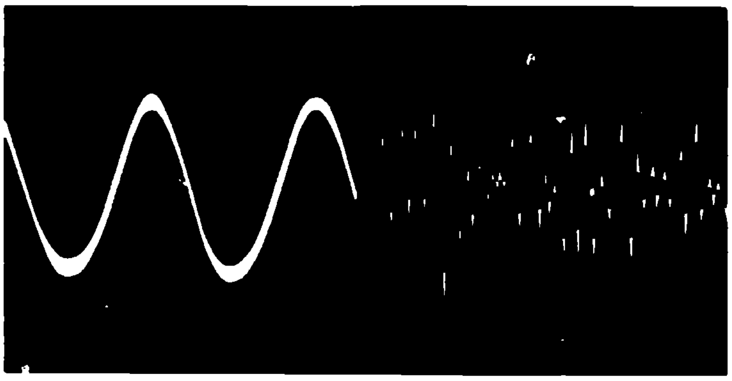
ABSTRACT

The first comprehensive study of the regional interconnection of cable television systems was made in the Twin Cities metropolitan area in 1973 and 1974. Five prototype interconnection system options were developed using existing technology. Selection of an interconnection system is an important public policy issue that demands thorough study; the legal status of such systems is unclear. Extensive data on capital costs and computer and television software costs are included. (Author/PF)

Planning Interconnection Systems:

Options for the Twin Cities Metropolitan Area



The Cable Television Information Center
The Urban Institute

Metropolitan Council of the Twin Cities Area

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SUMMARY

The following report, Planning Interconnection Systems: Options for the Twin Cities Metropolitan Area, is the first comprehensive study of the regional interconnection of cable television systems ever carried out.

In its analysis, the report describes five interconnection system options for the Twin Cities metropolitan area, each of which can be built with existing technology. The design options are intended to address two fundamental questions faced by the Metropolitan Council of the Twin Cities Area: First, what level of interconnection facilities is needed for public use in the Twin Cities area? Second, should an interconnection system be built to support delivery of public services via cable systems, or should there be a public communications network for the delivery of public services independent of cable television systems?

Before the design of these systems was undertaken, the Interconnection Subcommittee of the Council's Advisory Committee on Cable Communications--with the cooperation and assistance of the Cable Television Information Center--conducted a survey across the metropolitan area to determine potential applications of an interconnection system. This use ascertainment process included discussions led by the Interconnection Subcommittee with various potential users in the region such as the University of Minnesota, private colleges and junior colleges, public school systems, arts and culture centers, banks,

large corporations, video centers and others. The result of these meetings was a group of 46 largely hypothetical use projects involving hundreds of institutions in the area. These projects were classified into three categories of applications: One-way cable services, closed circuit point-to-point services and two-way interactive uses.

The five interconnection systems that were then engineered were designed to meet, in varying degrees, these uses. The design work took into account two alternative possibilities: 1) That few cable systems would be built over the near term in the area; or 2) That there would be extensive cable television service in the area. A description of the system options, including capital costs and services, follows:

--Option I. Uses microwave to provide eight video and four return audio channels to locations equipped with receivers, at a cost of $249,920. The option is designed with the expectation that there would be few or no cable systems in the area.

--Option II. Uses a two-way cable network to link 25 community information and service centers (CISC's) in the area, and provides service to closed circuit users. The option is also designed with the expectation that there would be few cable systems in existence, and its overall capital costs, including equipment for each CISC, are $6,103,653.

--Option III. Delivers 16 channels of television via microwave to cable television systems, with limited microwave transmitted to an interconnection switching center. This option would provide both commercial and public service programming, with the total capital costs for the project

being $481,140.

--Option IV. Uses a two-way cable network to connect all metropolitan cable systems with an interconnection switching center, plus a microwave system that broadcasts four channels of programming to cable systems and other institutions equipped with receivers. In addition to providing commercial and public service programming, this system can serve closed circuit users. Capital costs for the system are $1,432,200.

--Option V. Has a two-way network interconnecting 25 CISC's and all metropolitan area cable systems with a master control center; and a microwave system broadcasting to the interconnected cable systems as well as to outlying institutions. All three categories of service--one-way cable service, closed-circuit point-to-point service and two-way interactive service--are provided by this option. The capital costs are $7,323,255.

Options IV and V additionally assume that a satellite earth receiver station is used to link the local interconnection system with potential national satellite networks.

The community information and service center network designed for Options II and V is a response to three problems related to the possible public benefits of cable television:

1) The fact that not everyone will subscribe to cable television service;

2) The fact that two-way services will be activated on a large scale only when they are demonstrated to be cost-effective; and

3) The fact that implementation of two-way services requires expensive terminal equipment.

The CISC's could provide municipal government services, two-way interactive instruction and other public benefits. Each of the (hypothetical) 25 CISC's designed for the Twin Cities area was equipped with the following facilities: A small telecasting and receiving studio and a larger audience studio; "express counter" information terminals (the video equivalent of dialing the telephone to receive recorded messages); and interactive television terminals, which utilize color moving (rather than still) video. The allocation of channels for both transmitting and receiving information in the CISC system is a surprisingly complex matter. The design of such a system involves the simultaneous calculation of the interaction among dozens of engineering and cost variables. For the purposes of this study, the center designed and programmed a network analysis model capable of executing the required design, subject to least cost constraints.

The five prototype interconnection systems demonstrate various levels of interconnection service which can be provided with state of the art technology. The design options are particularly useful since they anticipate the practical question of the pacing of cable system development across the metropolitan area, and because they demonstrate how various types of communications services can be accommodated.

The five prototypes are also subjected to economic analysis. To facilitate this analysis, the center developed a computer-based economic model called the Interconnection Tariff model. Rather than estimating the future feasibility of each system, the model assumes demand for the various systems in order to explore how they might work and to estimate service prices that would have to

be charged to produce a specified return on investment. The model also develops pro forma financial statements which illustrate the projected financial operation of each interconnection system over 10 years under two different sets of financial assumptions. Additionally, a formula was developed to calculate the "hook-up charge" a user would pay to connect his or her facilities to the nearest interconnection system. Finally, it was assumed that a CISC company, owning the 25 CISC's and the CISC computer control facilities, would operate separately from an entity owning the cable network, and would lease channel capacity necessary to connect those CISC's.

The costs of providing downstream service (i.e., signals traveling from the headend to users) under Options I and III--both microwave options--do not differ significantly. Because of the greater variety of signals provided to CISC locations in Options II and V, the cost of using the CISC cable network was higher per channel mile than the cost of using the cable system headend network. There are significant economies of scale operating between Options II and V and between Options IV and V, although in the latter case such economies are offset by the high costs of the CISC network.

Prices of the CISC services such as video teleconferencing and use of express counter and interactive television terminals might be reasonable, though it is difficult to predict what the market for such services is. The cost of interconnection services provided by these prototype systems appear equal to or less than the cost of the same services provided by other existing methods of transmission, including the telephone, especially when a large number of services are involved.

Finally, after a discussion of the pertinent federal and state legislation that would affect the regulatory structure of the interconnection system, the report outlines recommendations for procedural steps the Metropolitan Council might take. Because there are no existing interconnection systems, federal and state authorities have not considered regulatory problems associated with establishment of such a system. An entity providing communications services to a region comprised of many political jurisdictions would require regulatory supervision of both daily operational questions as well as long-range policy planning.

During the period in which the council is considering its options and drawing up its long-range plans, it should at the same time be carrying out an informational program for potential users; ascertaining what the actual demands on the system will be; exploring in detail all legal issues involved; and closely monitoring developments on the federal level that may affect microwave facilities, and developments on the local level that involve franchising activities in the seven-county metropolitan area. The interim period can also include more engineering and financial analysis. Then the council will be ready to hold public hearings for debate of the policy questions involved: How the interconnection system will be financed and regulated.

The following is a summary of each of the report's eight chapters:

--Chapter One discusses the background to the study.

--Chapter Two defines local interconnection, describes its technological components and discusses why local interconnection is an important public policy issue.

--Chapter Three describes the process employed by the center and the council to develop assumptions about interconnection system demands.

--Chapter Four describes the five prototype interconnection systems.

--Chapter Five subjects those prototype systems to economic analysis.

--Chapter Six provides an overview of both television and computer software costs.

--Chapter Seven is a survey of the legal and regulatory factors affecting interconnection in the Twin Cities area.

--Chapter Eight generally discusses the regulation of interconnection systems and suggests a decision making and planning procedure for the implementation of the report.

As the first comprehensive examination of regional interconnection of cable television systems, this study has hopefully provided information in an area that had previously been undefined and unspecified. From the Metropolitan Council's point of view, the study is the first step in a series of actions that should be taken to plan interconnection systems across the Twin Cities area.

I. BACKGROUND TO THE STUDY

In November 1972, the Advisory Committee on Cable Communications of the Metropolitan Council of the Twin Cities Area submitted a final report to the Metropolitan Council. Among the recommendations made by the committee as a result of its study was that the Metro Council should undertake "a study of the costs and feasibility of different forms and standards for interconnection of cable systems."[1] Additionally, the council was urged to recommend that a statewide regulatory commission on cable communications establish standards for interconnection with the assistance of the Metropolitan Council. These recommendations were adopted by the council as its policy.

In May 1973, the state legislature passed legislation creating the Minnesota Commission on Cable Communications. Among the directives of that act was a provision enabling the Metro Council to "engage in a program of research and study concerning interconnection, ... regional use of cable communications and all other aspects [of cable communications] which may be of regional concern."[2] Pursuant to this authority and suggestion, both council staff members and representatives of the Advisory Committee on Cable Communications initiated discussions with the Cable Television Information Center in June 1973. The purpose of those discussions was to determine if

1. Report of the Advisory Committee on Cable Communications to the Metropolitan Council of the Twin Cities Area, November 30, 1972, St. Paul, Minnesota, p. 45.
2. Minnesota Annotated Statutes, Chapter 568, 1973.

there was any basis for developing a long-term working relationship between the council and the center.

A nonprofit advisory group funded by the Ford and Markle Foundations, the Cable Television Information Center was formed as part of The Urban Institute in 1972 to help local governmental officials reach sound decisions on the development of cable television in their communities. The center provides cities, counties, states and regional governments with legal, financial and technical data and assistance that can help ensure that this new communications technology serves the public interest. The center maintains a strict nonpolitical, nonadvocate position, supplying information without interfering in local decisions.

The Metropolitan Council is the regional planning and coordinating agency of government for the Twin Cities metropolitan area. The council was created by the Minnesota State Legislature in 1967, and reports to it frequently, making recommendations on ways to assure that metropolitan growth is rational, orderly and economic.

In essence, the Metro Council's job is to address the physical, economic and social problems that have regional impact and to plan or coordinate programs designed to solve these problems. At the same time, the council establishes guidelines for the orderly and economic growth of the seven-county metropolitan area and synchronizes public and private development efforts.

The council is composed of 14 part-time members appointed by the governor from combinations of state legislative districts in the metropolitan

area on the one-man, one-vote principle. The council's chairman, the 15th member, represents the area at large, and serves at the governor's pleasure. The council has a full-time staff and is supported by a tax levy augmented by state and federal contracts. The Cable Television Advisory Committee consists of 25 members and advises the council on cable television matters.

The discussions between the Cable Television Information Center and the Metropolitan Council led to the conclusion that it would be desirable for the center to provide assistance in several areas, particularly with regard to the study of the interconnection of cable television systems in the Twin Cities region. Accordingly, in November 1973, the center and the Metro Council signed a contract specifying the terms of the study. The joint study--the first attempt anywhere to design and calculate the costs of prototype interconnection systems composed of coaxial cable, microwave and satellite systems[1]--endeavored to accomplish the following:

1) Develop computer-based engineering and financial analytic models for interconnection systems that could be used in the Twin Cities area and elsewhere;

2) Define an appropriate set of assumed communications demands which might be placed on a regional interconnection system in the Twin Cities area;

1. However, the concept of cable television system interconnection is a possibility that has been examined by others. For example, interconnection of locally owned cable systems was offered as an alternative to the Rand Corporation's system designs for the metropolitan area of Dayton, Ohio. See MetroCable, January 1972, Washington, D.C., Urban Communications Group, p. 10. Additionally, a number of cable companies have formed a consortium and funded a study of satellite interconnection systems. See Broadcasting Magazine, June 25, 1973, p. 25.

3) Design a system capable of meeting those demands;

4) Specify capital and operating costs, alternative financing methods and pricing strategies that will enable the system to operate as a financially self-contained enterprise; and

5) Suggest ways in which the Metropolitan Council might make use of the results of the study.

The project was conceived of as a joint effort by the center and the council. Each group provided a director for the study. The center was also interested in devising a new service which would provide other local officials with a specific concept of an interconnection system in their communities. This proposed center service would facilitate administration of the complex organizational, management and regulatory issues involved in concerted action among several governmental jurisdictions. Therefore, the center assumed the bulk of the project's costs. The share of the total expenditures borne by the Metro Council represents those direct costs incurred by the center for focusing its research, development and planning efforts specifically toward the Twin Cities region.

From the beginning, two primary considerations have guided the center's study. First, the center has not presumed to make decisions for the Metropolitan Council. Rather, the intention has been to provide the council with a reasonably precise notion of an interconnection system for the metropolitan area and the questions which its development might raise. Second, the analysis should be considered the prototype of an interconnection system rather than a recommendation for a specific system. As the prototype,

its function is to serve as an embarkation point for a more detailed, better informed survey of the region's communications needs and for the interconnection decision making process.

The center acknowledges its indebtedness to the following persons and groups in the Twin Cities area:

John Boland, chairman, Metropolitan Council of the Twin Cities Area; Douglas Hedin, chairman, Advisory Committee on Cable Communications of the Metropolitan Council; Adrian E. Herbst, chairman, Interconnection Subcommittee of the Metropolitan Council's Advisory Committee on Cable Communications; the Districting Subcommittee of the Metropolitan Council's Advisory Committee on Cable Communications; Jon Shafer, telecommunications planner of the Metropolitan Council staff and local project director for this study; Charles Hayes, staff, Minnesota Commission on Cable Communications; Pam Tucker, intern, Metropolitan Council; Gene Franchette, executive director, Metropolitan League of Municipalities, St. Paul; Robert Hinkley, president, Minnesota Cable Communications Association; Richard Cornelius, Department of Public Works, City of Minneapolis; and J.G. Ossendorf, utilities engineer, Minnesota Department of Highways.

II. INTERCONNECTION

> In a century characterized by an explosion of technologies, there has probably been no development with quite the impact of television. This medium has lent a sense of immediacy and intimacy to events in the life of the nation--and to events from halfway around the world, as they are beamed via satellite into the living rooms of even the most geographically isolated people. Intercommunication has transformed the U.S.A. into a citizen in the "Global Village," as well as a land whose inhabitants are in instant touch with its own pulse.
>
> Yet broadcast television, with all its ability to transfer a wide variety of experiences, is limited --first, to a mass audience, and second, to merely one-way communication. Broadcast television has altered our perceptions, has changed our lifestyles, but--for all of its power--has not contributed to the solution of many of the problems our society faces today.
>
> However, some answers may be found through cable television, with its [enormous capacity and] two-way communications capability.... Combined with developing satellite, videotape and cassette technologies, cable has the potential to bring greater diversity to TV programming, to deliver [some] important public services and to provide access to voices which have not been heard in the past.[1]

But little of this potential has yet been realized, particularly in urban markets with good broadcast TV reception. Most telecommunications experts agree, however, that satellite networking of cable television systems, the continuing development of pay-cable and creation of new

1. Cable Television Interconnection, 1974, Washington, D.C., Cable Television Information Center, p. 7.

communications services for businesses are expected to give cable television the financial impetus to enter urban markets.

The purpose of this chapter is twofold: first, it will define local interconnection and introduce the technological components of the systems which will be discussed in Chapter IV; and, second, it will suggest reasons why the Metropolitan Council should be interested in the orderly development of local interconnection.

LOCAL INTERCONNECTION: DEFINITION AND TECHNOLOGICAL COMPONENTS

DEFINITION

Local interconnection in this report will include two concepts. In the first, more typical instance, it is defined as a communications system which links together cable TV systems in several local communities with terminals from national networks (satellite receivers, long haul terrestrial microwave and others). Local interconnection in this sense permits transmission of national programming to each cable system for further distribution to subscribers. These interconnection systems, if properly designed, can also be used to carry programs back and forth between separate cable systems, enabling each to use the others' programs. The second definition is a broader concept, and is one which grew out of this study's goal of designing communications systems to meet regional needs. It is operative when there are few or no existing cable systems in the metropolitan area. In those cases, local interconnection is an areawide or regional

communications network.[1]

It should be noted from the onset that these notions of local interconnection are much broader and relatively more recent than a more traditional concept of local interconnection. That concept--which is occasionally considered in local cable television legislation--views interconnection only as a narrow question of the technical compatibility of neighboring cable systems. This is not really at issue since modern cable television systems can be made technically compatible with commercially available equipment at modest expense. Moreover, focusing upon this question obscures the more important issues of the public potential of local interconnection.

TECHNOLOGICAL COMPONENTS

Interconnection facilities can consist of communications links between two or more places via coaxial cable or microwave radio transmitters and receivers (LDS, ITFS and MDS), each of which is discussed in the following pages and summarized in Table 1 on page 13.

COAXIAL CABLE

Coaxial cable can be used either for one-way or two-way communications between two points less than 20 miles apart, when large channel capacities are needed. The cable is the same type as that used for the trunk arteries in a cable television system and, depending upon performance

1. The difference between both cases of local interconnection and national interconnection networks should be noted. The latter do not include equipment for direct connection to cable system headends and are conceived of as systems operating on a "long haul" basis, connecting areas distant from each other. The American Telephone and Telegraph Company is the largest and best known of these national communications networks. Satellite networking--envisioned as a method of connecting distant cable systems with each other--will be another national interconnection network.

requirements, may vary in diameter from one-half to one inch or more.

MICROWAVE RELAY

Microwave radio operates at frequencies much higher than those of broadcast television and cable systems. It was first developed to carry the signals of one or two broadcast TV channels over long distances by means of chains of receivers and transmitters 20 to 30 miles apart. Cable television systems use this system to "import" distant broadcast television channels and, increasingly, special programming for pay-cable.

In recent years, the Federal Communications Commission has authorized microwave frequencies for use in local interconnection. There are several kinds of systems, and each is authorized for specific purposes.

LOCAL DISTRIBUTION SERVICE (LDS). The most important microwave system for cable television interconnection is Local Distribution Service (LDS). It is used to deliver as many as 39 television channels from a single transmitter to a number of receivers located in a 20- to 25-mile radius around the transmitter. The FCC intended that LDS provide interconnection of many cable system headends, especially in urban areas where geographic barriers or the high cost of underground construction make cable interconnection prohibitively expensive. LDS is part of a general service designated for cable system operators by the FCC known as cable television relay (CAR) service.

The major weakness of LDS microwave is a similarity to broadcast television. Generally, once an LDS transmitter is in operation, the frequencies it occupies cannot be used by another LDS transmitter within

15 miles. Additionally, although LDS is capable of very high channel capacity, it is predominantly a one-way medium with only very restricted two-way usage.[1] The high one-way capability is suitable for local distribution of satellite-delivered national programming, as it was designed to be. It is less useful as a means of signal carriage from one headend to others, from universities to schools and for other interconnection requirements which involve many local program sources as well as consumers.

MULTIPOINT DISTRIBUTION SERVICE (MDS). Another mode of microwave service is called Multipoint Distribution Service (MDS). This service is basically a fixed station which transmits to a large number of receivers in an area. The FCC has authorized a narrow, previously unused frequency of the electromagnetic spectrum for microwave transmission of data or television in urban areas. Commercial interest has grown recently in the possibilities of using this service to deliver pay television channels directly over-the-air to hotels and apartments without involving cable system operators, who share the revenues of a pay-cable venture. Further, entrepreneurs do not need a franchise from the city in which they operate.

Like LDS, MDS is mainly a one-way broadcast medium, with limited potential for two-way capability. It is presently authorized 12 megahertz (MHz) of frequency bandwidth, enough for two television channels. Thus, its potential for local interconnection is limited. It is not used in any of the

1. Several LDS equipment suppliers are developing a single channel microwave link which permits each cable system headend to communicate back to the central LDS facility. See p. 72, Chapter IV.

system options in Chapter IV.

INSTRUCTIONAL TELEVISION FIXED SERVICE (ITFS). Instructional Television Fixed Service (ITFS) is a microwave system which transmits instructional programming from a fixed point to one or more fixed receiving stations. It was authorized by the FCC as a means for the local distribution of educational material by educational, governmental or other nonprofit entities.

There are two general types of ITFS applications. The most common is the use of a central studio for originating educational programs which are then beamed via an omnidirectional antenna to all of the schools in the community. Potentially, cable system headends could also receive these signals for further distribution to more distant schools or home subscribers. The second application is the use of a directional antenna to transmit programming from a single school or university to a central point, for further distribution via cable, LDS or ITFS microwave elsewhere.

An ITFS system consists of one or more four-channel transmitters and sets of one or more receivers. ITFS transmitters are more expensive per channel than LDS transmitters, but they are also more powerful. Additionally, the receivers used for ITFS cost considerably less than LDS receivers. The result is that ITFS is efficient for transmission of from four to eight or more channels to many reception points over a large area. LDS, on the other hand, is efficient for transmission of up to 39 channels to a more modest number of reception points, within a smaller area.

Seven bands of the electromagnetic spectrum (labeled A through G), each with four channels of television allocated to it (for a total of 28 channels),

are available for ITFS licensing in a specific geographical area. The ITFS receiving stations automatically convert the received signals to VHF television channels 7, 9, 11 and 13.

ITFS has not been widely utilized by educational institutions in the United States, partly because of a lag in development of classroom instructional programming. Its real benefit may lie in the future, as a component of a local interconnection system.

TABLE 1. SUMMARY OF INTERCONNECTION TECHNIQUES

Component	Nature of Service	Limitations of Service	Capacity
Coaxial Cable	One-way or two-way communication between two points	20-mile radius from central hub for large numbers of channels	Up to 38 television channels
Microwave			
LDS	Microwave transmission from a single transmitter to many cable headends made available by FCC for purpose of cable system interconnection	20- to 25-mile radius from central hub. Basically one-way medium, although capable of limited two-way service.	39 television channels
MDS	Similar to LDS. Microwave transmission in urban areas of data or television from one source to many receivers. Also seen as a means of delivering pay TV without using cable systems.	One-way, and small capacity	Two channels
ITFS	Allocated to educational needs. Uses transmitters to deliver TV signals from a single source to many receivers over a large area. May also be used for transmitting programming from a school or university to a central point.	Little use to date because of lag in development of classroom programming	Seven bands of four channels (or 28 channels)

LOCAL INTERCONNECTION--A PUBLIC POLICY ISSUE

At this point the question that can fairly be asked is, "Why should regional policymakers such as the Metropolitan Council be concerned with these various technologies and their orderly development?" The answer, simply put, is first, that there are considerable public communications benefits to be realized by local interconnection; and second, it is unlikely that these benefits will be obtained by the commercial development of cable television systems across a metropolitan area without regional supervision.

PUBLIC BENEFITS OF LOCAL INTERCONNECTION

If properly devised, local interconnection systems offer three important kinds of public communications benefits:

1) Local interconnection and the sharing of facilities can enrich the quality of program material offered on the access channels of an individual cable system.

2) Local interconnection permits the link-up of specialized audiences with specialized program sources.

3) Local interconnection permits the delivery of public services to people and agencies not served by cable TV systems.[1]

PROGRAM ENRICHMENT

In its cable television rules promulgated in 1972, the FCC requires cable television systems constructed in the 100 largest television markets

1. See Table 2, at the conclusion of Chapter III, which summarizes all the hypothetical uses and services--both public and commercial--which were suggested for the prototype Twin Cities interconnection systems.

to designate for public use one access channel each to educational authorities, local governments and the general public.[1] In addition, the commission requires that a cable system with 3,500 or more subscribers must operate "to a significant extent as a local outlet by origination cablecasting..."[2]

Both of these provisions are intended to guarantee local access to this important communications medium, and to ensure that cable television serves as an outlet for local expression. However, economic realities may tend to militate against the achievement of these goals. Capital and operating expenses for program production are costly and tend to rise dramatically as higher professional quality is sought. Broadcast television, for example, has largely become the creature of the three national networks, mainly in response to the need to reduce production costs per viewer by reaching mass audiences. Economic self-interest is likely to lead cable operators in the same direction, particularly as cable networks develop.

Local officials concerned with programming the three access channels must face these same economic realities. Although the FCC mandate reserves channels for local access, it does not stipulate specific equipment and production requirements for the use of the channels.[3] In most instances,

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1. 47 CFR 76.251 (a)(4).
2. The commission has commenced a rulemaking proceeding inquiring whether this rule should be altered or even repealed in its entirety. Notice of Proposed Rulemaking and of Inquiry, Docket No. 19988, __ FCC 2d __, FCC 74-315, (April 3, 1974).
3. The exception is the public access channel, for which the operator must provide minimum production facilities to users. 47 CFR 76.251 (a)(4).

it will fall to local governmental officials and educational authorities to provide these resources. In small communities, the cost per viewer will be high and may prove just as economically unattractive to the keepers of the public purse as it does to advertisers who support broadcast television.

Local sharing of facilities can provide some relief. For example, five small communities at the fringe of a major metropolitan area may each not be able to afford a color production studio for public service cablecasting on the local government access channel. Operating together, however, they may be able to support a single facility that serves all five.

Similarly, cable operators in the five communities may feel they cannot afford more than minimal facilities for public access--for instance, a one-half inch black and white videotape recorder. Combining efforts might permit the operation of a small studio as well as two or three portable videotapé recorders, perhaps with a full- or part-time technical assistant.

It might be argued that pooling facilities could retard the development of public access, since the studio would not be easily accessible to most users, and because users from all five communities would have to share a single public access channel. This need not be the case. Maintaining several portable videotape recorders would permit localized or neighborhood programming. Further, the interconnection facility might be designed to permit the distribution of two public access channels to each community if there were sufficient programming for each channel. The net result would be an improvement in public access for each community.

This example is meant to illustrate the possibilities that can benefit small communities which take advantage of the economies of scale principle.

For larger urban settings, the prospects for leavening the public services character of cable are in some respects even more exciting. These prospects are discussed in two sections which follow.

LINKING SPECIALIZED AUDIENCES TO SPECIALIZED PROGRAMMING

It is not the availability of channel capacity which has hindered the development of cable television. Present electronic equipment permits the carriage of as many as 40 channels in a single cable, and the next generation of equipment may provide as many as 55 channels. The lack of program sources, however, has been an obstacle. In this respect, local interconnection facilities may provide powerful assistance.

For example, in the Twin Cities area, the University of Minnesota has television studio facilities, production programming capability and a large audio-visual library. If there were no interconnection facility, only subscribers to the local cable system serving the university could benefit from university programs. But interconnection would permit all cable subscribers in the metropolitan area to be served.

Similarly, if a cable TV system serving the central city were under minority ownership, it might well undertake a major programming effort for the benefit of its subscribers. But those minority citizens located in the suburbs or satellite cities could receive that special programming only if their system were interconnected with the central city system.

Cable systems seldom follow political and governmental jurisdictions other than city or county boundaries. Yet, increasingly, public services are

being coordinated and delivered on a metropolitan or regional basis. A state office of manpower development might undertake a daily or weekly job bank program series in which subscribers could telephone inquiries about specific jobs described on the program. Such an effort might be justifiable if a large enough portion of the target population could be reached at relatively low cost--a possibility with interconnected cable systems.

Some kinds of closed circuit uses of cable television require two-way communications. For example, many law enforcement agencies are developing communications networks on a state or regional basis between agencies. Metropolitan, state and county law enforcement agencies could be linked to a computer-supported data bank and communications system which permits rapid coordination of law enforcement activities.

Until recently, most of these systems have used mobile radio and data communications. Now, via interconnected cable systems, the prospect of video exchange of information among law enforcement agencies promises a major increase in communications capability. But to be effective, the system must provide cameras and receivers at each agency tied into the network.

None of these examples taken alone is likely to provide public officials sufficient rationale for construction of costly interconnection facilities. However, joint use of interconnection facilities, with costs shared by each user, may well make the benefits of interconnection attractive.

DELIVERY OF SERVICES TO THOSE NOT REACHED BY CABLE SYSTEMS

Public uses of telecommunications tend to be defined in terms of services that can be delivered over cable systems, partly because it is cable television that has caused so much excitement in the prospect of the "Wired Nation." Yet, even the most optimistic predictions for the growth of cable envision that no more than 60 per cent of the homes in the country will be wired by the end of the decade. Interconnection, conceived broadly, may provide the means of delivering some services to those not connected to cable.

For example, interconnection facilities can be used to link public telecommunications services directly to subscribing agencies. It is possible to use ITFS microwave as an interconnection mode in those cases where not all schools are tied into cable systems. Programming for classroom instruction might be transmitted via ITFS microwave to the headends of cable systems which service some schools, and broadcast direct to ITFS receivers in those schools not serviced by cable.

Furthermore, it is possible--as this report discusses-- to develop community information and service centers in order to make available the public services provided via cable to those citizens who are not cable subscribers. Such centers could provide a central two-way link between governmental, educational and other institutions and the public.

Both of these examples illustrate the potential of a properly organized interconnection facility which can extend public communications services beyond the reach of existing or potential cable systems.

WHY COMMERCIAL DEVELOPMENT OF INTERCONNECTION FACILITIES WILL NOT PRODUCE THESE BENEFITS

The microwave and satellite technologies referred to previously may lead to a highly sophisticated national system for the distribution of programming to cable system headends. But this commercial networking, for many reasons, may do little to enhance local programming and the provision of public communications services.

In the first place, commercial links to cable system headends will probably result in interconnection facilities which do not fit jurisdictional boundaries. LDS operators, for example, will construct their facilities to reach customers--mostly cable system headends--who will pay for national programming. Such a system design is unlikely to fully meet public needs.

Secondly, to bring programming from national networks directly to cable systems, commercial links will be only one-way systems. Public uses of cable such as those suggested earlier in this chapter may require audiences and program sources larger than those available to a single cable system, but more localized than a national network. The pooling of audiences and program sources at this regional level requires two-way switched facilities not likely to be provided commercially.

Finally, commercial networks will be linked to cable systems and thus will deliver services only to cable subscribers. The audience for public communications services is not so limited.

These reasons provide the rationale for an important new role for public officials at the regional level to promote the development of local

interconnection resources for public services. The Metropolitan Council is well situated to deal with this issue because of its stated interest in regional cable television matters (including interconnection) and, more importantly, because of its statutory responsibilities for regional planning in the Twin Cities area.

SUMMARY

Interconnection facilities can potentially serve two broad public purposes: They can permit the public services cable is capable of delivering to flourish; and they can permit the delivery of services, not only via cable television systems, but directly to users. Commercial forces will undoubtedly generate major interconnection facilities in tandem with the development of new national networks. But there is no convincing evidence to show that commercial development, without significant public direction and supervision, will be well suited to public local interconnection needs.

Interconnection facilities provide a means for stimulating the development of public telecommunications services. Planning for and operating such facilities provides a basis for regional planning among different jurisdictions. It also encourages local and state officials to begin thinking in terms of the larger issues of telecommunications policy planning rather than simply the regulation of cable television. Both implications are likely to influence the long range development of public communications.

III. DEVELOPING ASSUMPTIONS ABOUT INTERCONNECTION SYSTEM DEMANDS

One of the most vexing problems faced at the onset of this study was how to develop a set of fundamentally realistic demands for an interconnection system when there was no model for potential users to view. Put another way, the center and the council were faced with the classic "chicken and egg" problem. On the one hand, it was necessary to determine what groups and institutions might use such a system; this would facilitate designing a system which would meet localized communications needs. On the other, since no such system existed, it would be difficult to elicit realistic demands from potential users.

But adherence to the expressed goal of the project largely obviated this problem. Since the objective of the study was intended to be the development of prototype or pattern interconnection systems instead of "ready to build" systems, there was no need to solicit firm commitments for usage based upon an exhaustive survey of all potential users of the system. Rather, it proved sufficient to survey representatives of identified user groups. The results of this more modest approach were most satisfactory and are fully summarized in Table 2 at the conclusion of this chapter. The following is a more detailed description of how the user demands were actually developed.

PROCESS OF DEVELOPING USAGE ASSUMPTIONS

There were basically three phases to the process of developing use assumptions for the interconnection system. These were:

1) Preparation and presentation of background materials on interconnection and cable uses by the center for the council's Interconnection Subcommittee;

2) Solicitation of detailed use descriptions in the metropolitan area by the Interconnection Subcommittee, and designation of hypothetical franchise zones for the seven-county area by the council's Districting Subcommittee; and

3) Refinement and grouping of the proposed uses by the Interconnection Subcommittee and the center.

As might be expected, there were a number of steps involved in each phase. The first phase generally involved acquainting the Interconnection Subcommittee with the dimensions of the proposed project; what might be involved from a technical perspective in an interconnection system; and the nature of the information the center would need to design prototype systems. At the time the contract for the project was signed in November 1973, four members of the center's staff met with this subcommittee's members. The purpose of these extensive sessions was to brief subcommittee members on the various technologies which might be used in an interconnection system, illustrating various uses for such a system and responding to questions concerning the center's proposal. In preparation for this first series of meetings, the center had prepared for the subcommittee and council staff

a thorough summary of cable television uses designed to suggest various demands which might be made on the system. Additionally, a final draft of Cable Television Interconnection[1] was distributed to the subcommittee as background material to supplement the oral presentation and explanation made at this first series of meetings.

Considerable attention at these sessions was directed to the format in which information on potential uses would be received by the subcommittee and passed on to the center. In preparation for this meeting, the center had designed a draft questionnaire which was to be used in gathering such use information. The questionnaire sought details on the following: the channel capacity required for the individual suggested project; whether two-way capability was needed; the production equipment required; if the proposed use was either operational or nearly operational; and the budget set aside for the project. Subcommittee members and center personnel discussed the format at length, amending and clarifying various provisions for the finalized questionnaire (see Appendix for copy of "Detailed Use Description"). Before the subcommittee began the process of locating potential users, the center furnished each member with a sample version of a completed form for illustrative purposes. Finally, it was agreed that all potential uses would be summarized on the questionnaires.

Following these sessions, the second phase of that process began. The Interconnection Subcommittee and the Metro Council staff divided into five

1. This report was completed and released by the center in June 1974 as part of its Publications Service series.

small task forces. The five divisions selected were based upon the following categories of prospective users: governmental, educational, cultural and public access, business and commercial, and health services. Subcommittee members responsible for each of these areas used a series of approaches in contacting and soliciting information from the various individuals, groups and institutions in each category. In some cases, the questionnaires were mailed to prospective users with a cover letter explaining the project plus some background material on interconnection. Some subcommittee members talked individually with potential users, explaining the possibilities of an interconnection system and assisting in the completion of the forms. Others prepared supplemental materials, met with large numbers of persons in their assigned categories and coordinated on a broad scale the development of the various demands. Metro Council staff personnel assisted at these varying levels of subcommittee activity and coordinated communications between center staff and subcommittee members. When this process was completed, questionnaires were forwarded to the center.

At the same time the Interconnection Subcommittee was preparing the questionnaires, the Districting Subcommittee was developing hypothetical franchise zones for the study. One of the functions of the interconnection systems is to connect the cable system headends of the area. As a result it was necessary to have an indication of the boundaries of each of the cable television systems which might be located in the metropolitan area. Once the center was provided with this set of hypothetical zones,

locations for headends which would serve both the respective cable systems and act as hubs for the interconnection system could be established. This placement of cable system headends in the hypothetical zones was done in adherence to basic cable television engineering standards. Among the principal criteria used by the subcommittee in its selection of hypothetical zones were the Metropolitan Council's interim development framework policies;[1] population, household and employment forecasts; development trends; and existing urban service investments. To accommodate the fact that some cable franchising had already occurred in the area, two sets of hypothetical zones were developed by the Districting Subcommittee (see Appendix). Additionally, the subcommittee furnished the center with assumptions concerning where cable might develop in the rural areas, the active urbanization areas and in the outlying, freestanding cities.

Finally, it should be noted that the districts hypothesized were developed solely to allow the center to make some sound engineering assumptions for the interconnection study. They in no way represent the Districting Subcommittee's final thinking on the issue of designated franchise zones in the Twin Cities area.[2]

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1. See generally, Metropolitan Development Framework Interim Policies, February 14, 1974, St. Paul, Minnesota, Metropolitan Council of the Twin Cities Area. These interim policies are part of the council's efforts to develop a comprehensive growth plan for the Twin Cities area. Drafts of this report were available to the Districting Subcommittee during its consideration of the hypothetical franchise zones.
2. Under the Minnesota Cable Communications Act, the State Commission on Cable Communications is responsible for establishing standards for the size of cable franchising zones in the Twin Cities area. The commission is directed by the law to consult with the Metropolitan Council before adopting these standards. Minnesota Statutes, Chapter 268, Section 5, Subdivision 6.

Upon receiving the completed use questionnaires described earlier, center staff members began the final portion of the use survey project. The center attempted to categorize in some meaningful fashion the information that had been received from the council The questionnaire data was grouped into three general categories of proposed users:

1) Users of basic, one-way cable service

2) Closed-circuit users

3) Users of two-way, interactive services.

In some cases, users could be appropriately assigned to two categories according to the nature of the proposed service.[1]

The first classification categorized at various channel capacity levels those uses which involved one-way programming to be delivered to all cable television subscribers or to a large number of institutional users.[2]

The second category contained "point-to-point" networks, specialized closed-circuit uses and some digital computer projects. Some of these uses additionally called for some two-way audio and video capacity.

The third category introduced the concept of community information and service centers--area neighborhoodwide centers established to provide communications services to all citizens via interactive cable communications.

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1 For example, in Use #21 (see Table 1 at the conclusion of this chapter), the Agricultural Extension Service of the Institute of Agriculture at the University of Minnesota was interested in presenting programming aimed at both the general public and some specific audiences. In the case of the specific audience programming, interactive communications was requested. Thus, the use could be categorized as both a one-way cable service (the general audience programming) and a two-way interactive service (the specific audience programming).

2. This category, because it is comprised largely of educational uses, is referred to in Chapters IV, V, VI and VII as the "educational package."

These centers, which are discussed in greater detail in Chapter IV of this report, are an attempt to provide as many persons as possible with reasonably priced communications services.

Memoranda from various center staff members to the Interconnection Subcommittee were prepared for each of the three groups of users. In these memoranda (see Appendix) the center summarized, interpreted and, in some cases, questioned the data provided by the council subcommittee. The purpose of this process was twofold: first, it was necessary to organize the assumed projects into general categories which corresponded roughly to the various levels of technological services which the interconnection systems could provide; and second, such a categorization was necessary to expedite future conversations between the center and the subcommittee, refining and clarifying the suggested uses.

After assigning each proposed use to one of the three groups and reporting this to the subcommittee, center staff members met again with the council staff and subcommittee. At this time, modifications and refinements of the uses originally submitted were made. Additionally, the various levels of interconnection service (as suggested by the three categories) were discussed. The end product of these sessions was a set of detailed, assumed demands which served as the inputs for the computer-based engineering modeling performed by the center.

CONCLUSIONS

Generally, the results of the above-described process were most satisfactory. The Interconnection Subcommittee uncovered a surprisingly

large and varied number of potential users of an interconnection system. The hypothetical uses cover a wide range of educational, cultural, governmental and commercial functions. The University of Minnesota, private colleges and junior colleges, public school systems, arts and culture centers, banks, corporations, video centers and many other institutions expressed interest in the project and suggested innovative, well considered demands on the system.

Moreover, the potential uses suggested lend themselves in many instances to significant sharing of expensive programming equipment, distribution facilities and channel space. In the first category of basic, one-way cable service, for example, more than twenty public and commercial institutions proposed projects. Initially, these demands indicated a need for approximately 29 television channels. After examining the hypothetical days and times these channels would be needed and discussing with the various users the possibilities for sharing channels and facilities, it became possible to satisfy these potential demands with 15 channels. Thus additional channel capacity was made available for other uses.

In addition to this "paring-down" process, some of the suggested uses were not planned for in any of the system designs illustrated in Chapter IV. For example, the representative of the St. Paul Public Schools had developed for that municipality's City Council a sophisticated "Preliminary Policy Statement." The statement applied exclusively to intra-St. Paul uses and thus did not place any demands on any areawide interconnection system.

Finally, as might be expected, there were some significant limitations on the process. The subcomm''ee had only eight weeks to contact and educate potential users and to develop the eventual 46 assumed use projects. While hundreds of inquiries were made by the subcommittee members during that period, it was impossible to conduct an exhaustive survey of all, or even most, potential users. Moreover, a number of potential users were apprehensive that the purpose of this use assumption project was to solicit actual commitments for using an interconnection system rather than for the development of prototype systems. In many of these cases, no reponses were made to the questionnaires. It should be noted that the uses proposed were proffered only as assumptions for purposes of this study. No commitments were made by any of the potential users, nor were any commitments needed. As stated before, the purpose of the project was to deve'op a prototype interconnection system, indicating possible uses and possible costs, in order to allow more substantial plans to follow in the future. Because actual budget and staff commitments will be needed from potential users, a more comprehensive demand survey must be completed before any definitive interconnection system can be planned for the future.

TABLE 2. SUMMARY OF HYPOTHETICAL USER DEMANDS

CATEGORY I--BASIC ONE-WAY CABLE SERVICE

USE NUMBER	SPONSORING AGENCY	DESCRIPTION OF USE
2.	University of Minnesota (U. of M.), Continuing Education and Extension (CEE) Minnesota State Bar Association *	Continuing education programs for lawyers
3.	Minnesota Community Colleges *	Instructional programming
4.	Minnesota Community Colleges *	Community College News Service--describing current events at the Community Colleges, and coverage of special events
5.	U. of M., CEE, Department of Extension Classes	Presentation of lectures in credit and noncredit courses, and presentation of special events
8.	U. of M., CEE, Woman's Program Section *	Presentation of lectures and seminars in credit and noncredit courses
10.	U. of M., CEE, Department of Independent Study	Presentation of programming to specific groups such as prisoners, law enforcement employees, medical employees, businesspersons and teachers
11.	U. of M., CEE, Department of Independent Study	Presentation to general public of high-interest programming in areas such as drug use and abuse, environmental studies, sex education and child psychology

USE NUMBER	SPONSORING AGENCY	DESCRIPTION OF USE
12.	U. of M., School of Dentistry	Presentation of dental hygiene information
15.	Augsburg College, Bethel College, College of St. Catherine, College of St. Thomas, Concordia College, Hamline University and Macalester College	Presentation of lectures in credit and noncredit courses
17.	U. of M., Audio-Visual Library Services	Presentation, on a "preview" basis, of newly released audio-visual educational and library materials
18.	U. of M., Audio-Visual Library Services	Presentation of course material on a semester basis
19.	U. of M., CEE, Fire Service Information, Research and Education (F.I.R.E.) Center	Presentation of fire service training and education program
21.	U. of M., Institute of Agriculture, Agricultural Extension Service *	Presentation of both educational and informational agricultural programs
22.	U. of M., Institute of Agriculture, Agricultural Extension Service	Presentation of youth nutritional programming
24.	U. of M., College of Education, Instructional Systems Resource Center *	Presentation of lectures in teacher education courses
25.	Minnesota State Orchestra League	Presentation of community, youth and college orchestra and choral group concerts

USE NUMBER	SPONSORING AGENCY	DESCRIPTION OF USE
26.	St. Cloud State College	Presentation of course material
27.	Minnesota Metropolitan State College, Winona State College and other Minnesota State Colleges	Presentation of lectures in credit and noncredit courses
28.	Metropolitan Area Community Colleges *	Presentation of lectures in credit courses
30.	Television Services Unlimited	Presentation of lectures in credit courses
31.	Metropolitan Airport Commission	Presentation of flight arrival and departure information
32.	Minnesota Student Association, University Community Video Center	Presentation of center-produced videotape material
34.	Hennepin County Library	Presentation of videotaped community events
36.	St. Paul Public Schools and New City Schools	Presentation of student produced videotaped materials on socio-political and educational issues
40.	Archdiocese of St. Paul-Minneapolis, Communication Offices, Education Center, Catholic Welfare and Charities	Presentation of religious educational material for clergy and religious, family religious educational programming and counseling and crises intervention

USE NUMBER	SPONSORING AGENCY	DESCRIPTION OF USE
41.	University Community Video Center and Community Video Center - Minneapolis, Inc.	Presentation of center-produced video-taped material
44.	Northwestern Bank Corporation	Presentation of banking and data processing educational material
45.	Minnesota Mining and Manufacturing Corporation	Presentation of corporate communications

* NOTE: The uses marked above with an asterisk involve some two-way, interactive service. They are not repeated in Category III, "Two-Way, Interactive Services."

CATEGORY II--CLOSED CIRCUIT USERS

USE NUMBER	SPONSORING AGENCY	DESCRIPTION OF USE
9.	University of Minnesota (U. of M.), College of Education, Division of Curriculum Education, Instructional Systems Resource Center and the Minneapolis Public Schools	Students of education observing actual teaching at 20 metropolitanwide public schools. This would allow students located at the University of Minnesota's Peik Hall to observe classroom teaching methods without traveling to the classrooms.
13.	U. of M., Health Services Department and University Hospital	A two-way video network linking the University Hospital which is the central location and 15 outlying University Hospital affiliates. Program would allow observation of activities at all hospitals by students, as well as interactive video communications with the staffs at each affiliate.
14.	Augsburg College, Bethel College, College of St. Catherine, College of St. Thomas, Concordia College, Hamline University and Macalester College	A two-way project, using the College of St. Thomas as its central location, would allow each college to originate programming to be fed to the central location. Additionally, each school could receive two channels of this originated programming simultaneously.
29.	Minnesota Educational Computer Consortium	This project is designed to link each school and school administration office with a central computing facility

USE NUMBER	SPONSORING AGENCY	DESCRIPTION OF USE
38.	Walker Art Center, Institute of Art, Minneapolis College of Art and Design and St. Paul Arts and Science Center	Using the Walker Art Center as its central location, each arts center would be able to originate one channel of television for distribution to the other facilities (two-way video capacity allows simultaneous reception of one channel of programming)
42.	Gambles, Inc.	This computer-based project would link together two of the corporation's computer centers
43.	Metropolitanwide Computer Users	An area-wide computer-based project potentially linking any cable television subscriber with cable system trunk lines
46.	Control Data Corporation	Project would allow for video teleconferencing among five widely-scattered CDC locations in the metropolitan area. The control center is at CDC corporate headquarters in Bloomington. Additionally involved is a wideband data link between two of the company's computer centers.

CATEGORY III--TWO-WAY, INTERACTIVE SERVICES

USE NUMBER	SPONSORING AGENCY	DESCRIPTION OF USE
1.	University of Minnesota (U. of M.), Continuing Education and Extension (CEE), Department of Conferences	Presentation of conferencing material to areawide subordinate sites with interactive capability
6.	U. of M., CEE	Programming material available from a library of presentations on an accessing basis
7.	U. of M., Institute of Technology	Existing ITFS program with the Institute of Technology and cooperating corporations. Instructional television in engineering and science, with one-way video and two-way audio.
16.	U. of M., Audio-Visual Library Services (AVLS)	Project allowing persons at subordinate stations access to AVLS videotaped materials
20.	U. of M., and the Associated Press	On-demand news and information service
23.	U. of M., Institute of Agriculture, Agricultural Extension Service	Presentation of prepared instructional material to groups at subordinate stations which have interactive facilities for questioning instructor at central location
33.	Walker Art Center and the Institute of Art	Presentation of arts and cultural programming to subordinate stations with interactive facilities for accessing specific programming

USE NUMBER	SPONSORING AGENCY	DESCRIPTION OF USE
35.	Minnesota Student Association and the Telecommunications Corporation	An information and retrieval system containing computerized data on metropolitan area cultural and entertainment events
37.	University Community Video Center	Project for accessing from subordinate stations videotaped material prepared at the Video Center
39.	Guthrie Theatre and other metropolitan area theaters	Program for accessing information on ticket prices and seating availability at subordinate stations

IV. DESCRIPTIONS OF INTERCONNECTION SYSTEMS

This chapter describes five technologically feasible interconnection system prototypes and how they work. These options are intended to illustrate distinct public strategies toward regional telecommunications planning, specifically related to matters of interconnection. The five prototype, or design, options are proposed neither as the only choices available in the Twin Cities, nor as detailed specifications from which a system would be built. Rather, the options are intended to illustrate, in considerable technical and economic detail, the consequences of several different public choices. Chapter IV pinpoints design decisions for the Metropolitan Council, and analyzes the technical implications of each system option.

The design options set forth here are intended to address two fundamental issues facing the Metropolitan Council:

1) What level of interconnection facilities is needed for public use in the Twin Cities area?

2) Should an interconnection system be built to support the delivery of public services via cable television systems? Or should there be a public communications system for delivery of services independently of cable television systems?

Five kinds of system options are suggested in response to these questions. They are technically distinct, and are intended to illustrate the

possible ways that interconnection for public services delivery might be provided. All five options can be built with technology that exists today.

Two options are based upon the premise that cable systems will not be built locally, or will not be built quickly enough to support pressing public needs, or will not be utilized for the delivery of public services:

Option I: ITFS Microwave System--Few/No Existing Cable Television Systems. Eight channels of public video programming broadcast "downstream" to schools, libraries, community colleges and other institutions. "Downstream" means that signals travel from one central point to many others around it. In addition to the eight downstream video channels, there are four "upstream" voice channels. These bring voice signals back from any of the reception points to the central source of the video programming, for interactive communications, for example, between televised instructor and student audience.

Option II: CISC System--Few/No Existing Cable Television Systems. An advanced bidirectional cable network interconnecting 25 community information and service centers (CISC's) located throughout the metropolitan area.

Two options assume that cable systems will be built locally and will be available to deliver public services:

Option III: LDS and ITFS Interactive Microwave System. Four ITFS channels and 12 LDS channels delivered downstream via microwave to cable system headends, with one LDS channel (via a portable transmitter) from any three of the cable systems upstream to the microwave transmitter

and interconnection switching center.

Option IV: Cable and Microwave Interconnection of Cable Systems. A bidirectional cable network interconnecting all metropolitan cable system headends with an interconnection switching center, plus an ITFS microwave system, which broadcasts four channels of downstream programming to the interconnected cable headends as well as outlying schools, libraries and cable system headends beyond the range of the cable network.

One option assumes that cable systems and CISC's will be built locally, and will be available to carry public services:

Option V: Advanced Cable and Microwave Interconnection System For Both Cable Systems and CISC's. A bidirectional network interconnecting 25 CISC's and all metropolitan cable systems with a master control center, and an ITFS microwave system which broadcasts four channels of downstream programming to both the interconnected cable headends as well as outlying schools, libraries and cable system headends beyond the range of the cable network.

Options IV and V additionally assume that a satellite earth receiver station is used to link the local interconnection system with national satellite networks, initially with three received channels.

In Table 14 at the conclusion of this chapter, the ability of each of these five interconnection options to meet the hypothetical uses discussed in Chapter III is illustrated.

In the portion of the report which follows, each option is discussed in detail.

OPTION I: ITFS MICROWAVE SYSTEM--FEW/NO EXISTING CABLE TELEVISION SYSTEMS

This option is a low cost, low capability system. It would represent a decision that the development of cable would take place so slowly, or in such a way that public services are not likely to be delivered by cable systems; and further, that a major investment in an interconnection system for public use alone is not warranted.

The system itself would consist of ITFS transmitters and receivers. Eight single-channel ITFS transmitters would broadcast via a single omnidirectional antenna located atop the Minneapolis IDS Building to broadband microwave receivers at public institutions located within a radius of 35 miles from the transmitters.[1] In essence, this system is analogous to broadcast television, except that eight channels are broadcast instead of one.

Six of the eight channels are assumed to originate at the East Bank Campus of the University of Minnesota; they are carried by directional, low-powered ITFS microwave to the large transmitters downtown (again, assumed to be located on the IDS Building). Two channels are assumed to originate at the St. Paul Campus and are carried by low-powered directional microwave to the downtown facility, for re-broadcast to broadband microwave receivers throughout the region.

ITFS microwave reception equipment consists of a six-foot disk-

1. An omnidirectional antenna is one which sends signals of equal strength in all directions. A directional antenna radiates a signal beam in only one direction. A broadband receiver or transmitter receives or transmits a block of channels at once--as compared to single-channel receivers and transmitters.

shaped antenna, a four-channel receiver and downconverter (combined to change the four signals from microwave frequencies to VHF television frequencies) and a conventional television monitor. The FCC has allocated a number of bands of frequencies to ITFS. Seven of these bands--or 28 channels--are potentially available for use in the Twin Cities region. But a four-channel receiver automatically converts all ITFS microwave bands to channels 7, 9, 11 and 13. Thus, although the ITFS transmitter station would broadcast eight channels, any single receiver would receive only four of the eight channels. Two receiver/converters would, however, alleviate this problem and allow for reception of all eight channels.[1]

There exists equipment for voice-only upstream communications via ITFS microwave, to permit, for example, audiences to speak to a televised instructor. This capability can be provided by telephone, the cost of which does not differ significantly from providing the service by ITFS. Here it assumed that four of the eight video channels would be supported by voice upstream channels: both channels from the St. Paul Campus and two of the six channels from the East Bank Campus. Thus, it would be possible to conduct interactive televised instruction from both campuses--that is, instruction by television in which the students may speak (in turn)

1. Automatic downconversion of signals to VHF channels, however, would present minor engineering problems. Reception of all eight channels in a school, for example, would require either: 1) two separate downconverters feeding two separate cables, which would then have to be carried to each television set in the classroom; reception of all channels would require an A-B switch, as is used on dual cable systems or, 2) four of the channels could be reprocessed to other unused VHF channels at the school ITFS reception point.

to the instructor.

This system does not include origination equipment for programming the eight channels, since origination is not technically a part of the interconnection function. However, it should be kept in mind that eight channels presents a major programming effort--not unlike reproducing the commercial and public TV networks twice over. This problem will be addressed further in Chapter VI.

The channel allocations in each link of this option are as shown in Table 3 below.

TABLE 3. CHANNEL ALLOCATIONS, OPTION I

Number of Channels	Channel Use	From	To	Via
2	Video closed circuit	St. Paul Campus	IDS Building	ITFS
6	Video closed circuit	East Bank	IDS Building	ITFS
8	Video downstream	IDS	All reception points	ITFS
4	Audio upstream	4 remote points	IDS Building	ITFS
2	Audio closed circuit	IDS Building	St. Paul Campus	ITFS
2	Audio closed circuit	IDS Building	East Bank Campus	ITFS

There are difficulties in counting channels. In this system, there exist 16 video and eight audio channel links. However, half of the channels serve a relatively minor role, that of moving signals among control and

origination centers. A more accurate label of capability in this system is eight video and four audio channels. As will be noted and explained later, however, counting channels in a bidirectional cable network is more complicated.

The capital costs for Option I are as shown in Table 4 below.

TABLE 4. OPTION I, CAPITAL COSTS

A.	East Bank Campus	
	2 antennas	500
	4-channel low powered transmitter	24,000
	2-channel low powered transmitter	18,000
	4-channel audio receiver	800
	Construction and installation	5,000
	Subtotal	$ 48,300
B.	St. Paul Campus	
	2 antennas	700
	2-channel low powered transmitter	18,000
	4-channel audio receiver	800
	Construction and installation	4,000
	Subtotal	$ 23,500
C.	IDS Tower	
	8 10-watt transmitter @ $13,500	108,000
	8 demodulators @ $1,300	10,400
	omnidirectional antenna, 7' (transmit)	6,800
	omnidirectional antenna, 4' (receive)	3,000
	2 antennas, audio (transmit)	400
	4-channel audio receiver	800
	4-channel audio transmitter	6,000
	Construction and installation	20,000
	Subtotal	$ 155,400
	Subtotal	$ 227,200
	Spare parts, test equipment and contingency (10%)	$ 22,720
	Total costs for transmission	$ 249,920
D.	Receiver Facilities; One-Way Only--Per Location	
	Parabolic antenna, 6' (receive)	400
	4-channel receiver/downconverter	800
	Construction and installation	500
	Total	$ 1,700

E. Receiver Facilities with Voice Upstream--Per Location

Parabolic antenna, 6' (receive)	400
Parabolic antenna, 2' (transmit)	175
4-channel receiver/downconverter	800
Single channel audio transmitter	1,500
Construction and installation	700
Total	$ 3,575

This system would offer two classes of service: one-way video (for up to eight simultaneous users or program sources), and one-way video with audio response (up to four simultaneous users or program sources). One-way service is not identical to conventional television--that is, the cost of receiving equipment ($1,700) is prohibitively expensive for reception at home. One-way ITFS is suitable for private instruction to institutions such as libraries, schools, community colleges or other public places where programming could be exhibited in auditoriums or classrooms.

Upstream voice service adds to this medium the capacity to conduct interactive video instruction--that is, students at remote viewing locations can query the instructor on a live televised show about points which are not clear, and thereby help the instructor adjust pacing.

It is characteristic of broadcast service that viewers are not charged directly for the privilege of viewing.[1] Here, too, any institution which could afford the cost of ITFS reception equipment could receive four of the ITFS channels. This means that the interconnection service might be paid for by those who originate programming rather than those who receive it.

Details of the cost of this service and those who might make use of it are discussed in Chapter V.

1. Unless television signals are transmitted "scrambled" by an electronic device, requiring the viewer to have a de-scrambling device for which a fee could be charged.

OPTION II: CISC SYSTEM--FEW/NO EXISTING CABLE TELEVISION SYSTEMS

Three problems become apparent to those concerned about cable television's possible public benefits:

1) Not everyone will subscribe to the system.

2) Two-way services--which seem to have great public possibilities--are likely to be activated on a large scale only upon evidence that they are cost-effective.

3) Implementation of two-way service requires expensive terminal equipment in the homes of subscribers.

These problems, taken together, mean that the public benefits of cable television may not be available to those who need them most, and that the most innovative public uses--those involving two-way cable--may have to wait for the development of profitable commercial uses.

As an approach to these problems, a public community information and service centers (CISC) system is proposed. Such centers could provide a central point to which citizens could bring questions and problems relating to a wide variety of municipal services, linking the public to local government and public service agencies via two-way communications systems. They would permit the limited introduction of advanced two-way services such as computer assisted instruction and video telephone; and they might assist in making local government more responsive and comprehensible.[1]

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1. See Alan R. Siegel and Calvin W. Hübner. Special Services To Neighborhood and Home: A Community Telecommunication Demonstration Concept, Paper for the International Telemetering Conference, October 10, 1972.

The CISC's might be located in several different kinds of community facilities, to test and measure the impact of advanced communications capabilities in libraries, schools and community centers.

To investigate the prospects for such a system in the Twin Cities area, 25 CISC sites were selected by the center and the Metropolitan Council staff (see Table 5). There is nothing conclusive about these site selections; they were chosen with a rough sense of population distribution patterns and the possibility of adapting existing facilities to CISC use.

The equipment to be installed in each CISC should be derived from a detailed evaluation of the needs of the neighborhoods in question. Some areas might need more facilities than others. Here it is assumed that all CISC's are similarly equipped, in order to provide a simple basis for constructing a hypothetical system and observing how it would operate. Each CISC is supplied with the following sets of equipment:

1) An audience studio equipped with 100 to 200 seats, two color cameras, a control room, microphones and a large screen television projection system. This facility can be linked to similar facilities in other CISC's, for two-way video teleconferences.

2) A small studio with one color camera, one monitor, signal scrambling devices and a conference table, for private video telephone service with similar facilities in other CISC's.

3) "Express counter" information terminals. Conceptually, this is the video equivalent of dialing the telephone to receive recorded messages. It is sometimes called a "menu-type" retrieval system. Users could visually

browse through still video pictures displayed on a black and white television monitor and controlled by a small keyboard (not unlike a Touchtone© telephone keyboard). The express counter terminals in all CISC's would share a single downstream video and upstream data channel. The terminal includes a vidéo refresh unit--that is, a memory device, sometimes called a "frame grabber," for storing and replaying a single video picture transmitted in a fraction of a second via cable to the terminal. The refresh units permit a computer at the master control center (see description on page 60) to send a stream of still video pictures or frames--each individually addressed to a particular CISC terminal--at the rate of 30 or more frames per second. The upstream link permits the terminal user to command the computer to change pictures.

Such a system permits searches for such visual information as airplane schedules and routes, and theatre ticket availability.[1] It is assumed that initially two such terminals would be installed in each CISC.

4) Interactive television terminals. Interactive television terminals are similar to express counter terminals explained above except for the following:

--The monitor is color rather than black and white.

--The video refresh unit is installed at the master control center, permitting the terminal to have sole use of the video channel connecting it to the master control center. This in turn means that the terminal can be used to receive moving video as well as still video frames.

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1. See Table 2 at the conclusion of Chapter III.

--The terminal is enclosed in a carrel, to permit the user a degree of privacy.

--Each terminal is equipped with a full alphanumeric keyboard.

These differences are designed to permit lengthy interactions between user and source, for such purposes as computer assisted instruction, or of more pertinence, the previewing of audio-visual materials made available from a central resource for teachers, as proposed by the University of Minnesota's Audio-Visual Library Services.[1]

--A 3/4 inch color video cassette recorder and hand-held camera and a 1/2 inch black and white portable videotape recorder. These items permit a considerable amount of local videotaping at each CISC, either for local exhibition in the audience studio or for upstream transmission to other CISC's. It is expected that each CISC will become in effect a neighborhood audio-visual resource center, where the presence of other video facilities will encourage interest and involvement in local videotaping efforts.

THE CISC NETWORK

The CISC network consists of dual coaxial cables linking each CISC with a master control center, which was hypothetically located at the Minneapolis Campus of the University of Minnesota. One cable carries downstream signals; the other carries upstream signals.

FACTORS IN THE ALLOCATION OF CHANNELS

The allocation of channels for both upstream and downstream use in

1. See Table 2 at the conclusion of Chapter III.

the CISC system is a surprisingly complex matter. Three factors are involved.

DISTANCE OF THE CISC FROM THE MASTER CONTROL CENTER. As cable extends farther away from the control center, the ability of amplifiers to carry high frequency signals without distortion and "snow" declines. Thus, while 35 channels (300 MHz) can be delivered for distances of about 12 miles, further carriage of signals requires a lower frequency and, thus, fewer channels. The most distant CISC can receive six channels, which means that programming or teleconferencing to all CISC's simultaneously can be done only on six of the 35 downstream channels.

FOR DOWNSTREAM CHANNELS, THE RELATIONSHIP BETWEEN TIME-SHARED, DEDICATED AND PARTY-LINE CHANNEL USE. A dedicated channel is one that is reserved for a single party's use. A party-line channel serves several users. All receive the same video signal; or, stated differently, only one of the subscribers at any given time stipulates what all will receive. This type of arrangement would require prior scheduling, or a system of waiting in turn. A time-shared terminal provides a means of sharing the channel among a number of users almost simultaneously so that each user has sole use of his or her information that is transmitted over the channel. Such transmissions are routinely done with data signals, where groups of data signals are mixed together, transmitted over a channel and separated at their various destinations. This can be effected with still video frames by managing the addressing and transmission of individual video frames to each user by computer.

In practice, time-shared channels must be allocated permanently to that use. In the CISC network, one downstream channel and one upstream channel are assigned systemwide for time-shared use. Party-line channels are intended to permit simultaneous viewing at all CISC's, and are thus limited to the number of channels reaching the most distant CISC.[1] Ensuring that sufficient dedicated channels are available is a design problem. But in actual operation, all dedicated and party-line channels can be treated as being available for party-line or scheduled use.

FOR UPSTREAM USE, THE RELATIONSHIP BETWEEN TIME-SHARED AND DEDICATED USE. Although it is possible technically to enable a CISC at the remote end of a trunk artery to send signals upstream to another CISC closer to the switching center, in practice this would not be done. The upstream cable would be used exclusively to collect signals from each CISC and deliver them to the master switching center. Thus, there would be no capability for party-line transmission in the upstream cable. In this system, one channel is time-shared among all CISC's, for use as an upstream data channel in computer controlled interactive television applications. Two channels per CISC are dedicated for design purposes (although they may be scheduled on demand in actual operation).

The design of such a system involves simultaneous calculation of the interaction between dozens of engineering and cost variables, as well as the

1. It is possible to consider all channels delivered to the most distant CISC as party-line channels, but there would be no guarantee that channels would be available to that CISC if they were available to others. Here it is assumed that one downstream channel would be party-line in each artery.

geographic characteristics of the region to be networked. Such design efforts can only be accomplished by operations research and systems analysis techniques, using computers. For the purposes of this study, the center designed and programmed a network analysis model capable of executing the required design subject to least-cost constraints.[1] The design proposed here consists of 25 CISC's linked via a network of four arteries. Each artery consists of dual cable, one for upstream communications and one for downstream communications.

It should be noted that each of the sites selected for a CISC are in the best sense of the word, hypothetical--that is, they do not represent systematic search and selection processes which would justify their designation as fixed, legitimate public choices should such a system be built. Rather, they were selected by center and council staff members as feasible choices.

The potential site selections for the CISC's are shown in Table 5 below.

1. Details of the model's calculating methods and premises are set forth in the Appendix.

TABLE 5. POTENTIAL CISC SITES

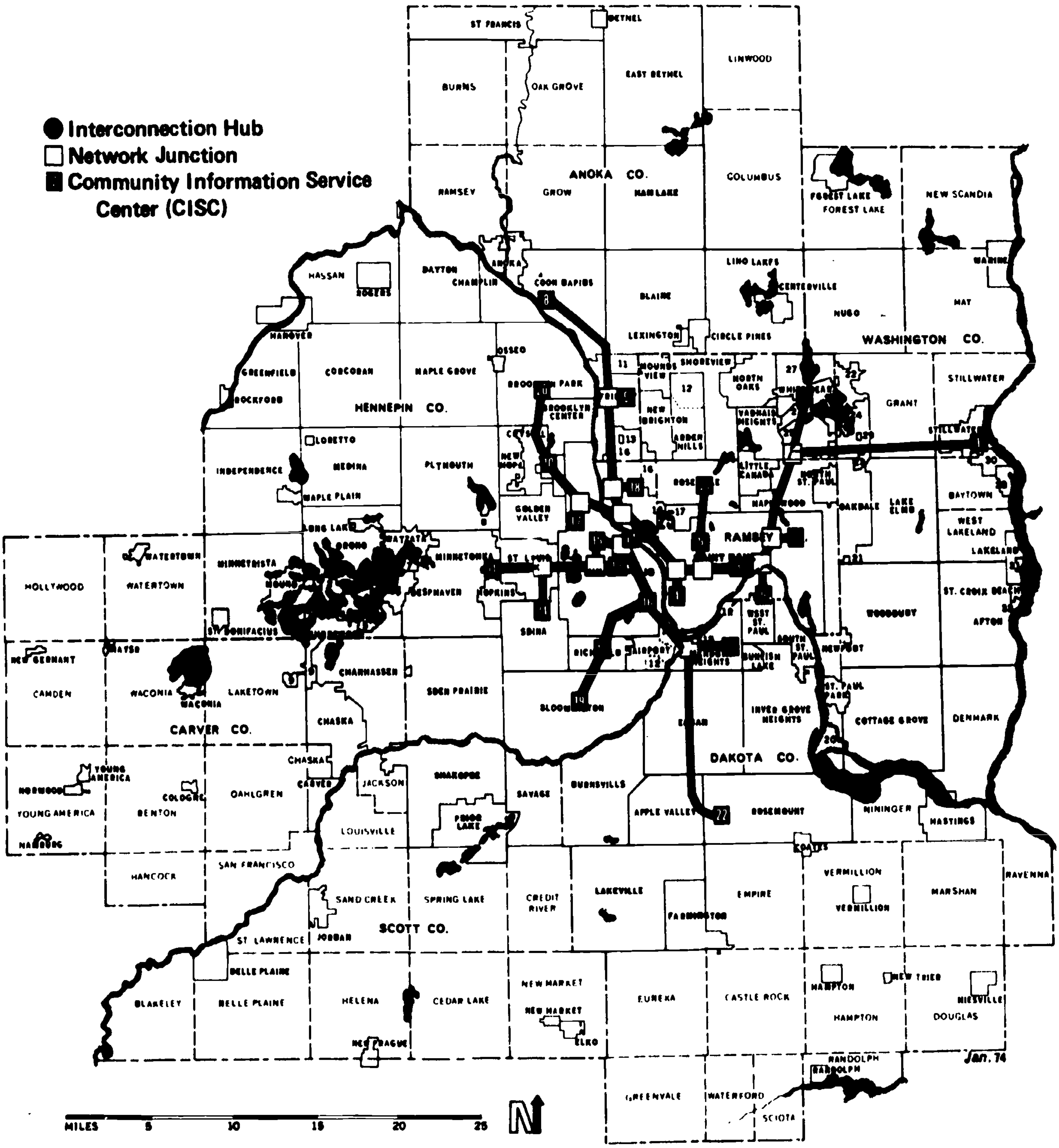
1. Stillwater High School, 7th and Orleans Streets, Stillwater
2. Hazel Park Junior High School, White Bear and Jessamine Avenues, St. Paul
3. St. Paul Vocational Trade School, Summit (John Ireland Boulevard) and Marshall Street, St. Paul
4. Macalester College, Grand Avenue and Macalester Street, St. Paul
5. St. Paul Public Library, 1080 University Avenue (University and Lexington Avenues), St. Paul
6. Humboldt High School, West Baker and Humboldt Streets, St. Paul
7. Lakewood Community College, 4th Street, White Bear Lake
8. Anoka-Ramsey Community College, off Cedar Rapids Road, Anoka
9. Fridley High School, 60th and Jefferson Streets, Fridley
10. Robbinsdale High School, 36th and Regent Streets, Robbinsdale
11. Eisenhower High School, 8th Street and Route 7, Hopkins
12. Richfield City Hall, 67th and Portland Streets, Richfield
13. Model Cities Communications Center, 3010 4th Avenue, South ($\frac{1}{2}$ block south of Lake Street), Minneapolis
14. University of Minnesota, West Bank Campus, University Community Center, 21st Avenue (north of the Washington Avenue Bridge), Minneapolis
15. Metropolitan Community College, Willow and Yale Place, Minneapolis
16. Roosevelt High School, East 41st Street and 29th Avenue, South, Minneapolis
17. North High School, Fremont and 17th Streets, Minneapolis
18. Edison High School, Monroe and 22nd Streets, Minneapolis
19. Lincoln High School, 88th and Queen Streets, Bloomington
20. Brooklyn High School and Junior High School, 75th Avenue and Noble Street, Brooklyn Park
21. Alexander Ramsey High School, Hamlin Street and Route 36 (Viking Drive), Roseville
22. Rosemount High School, Northwest Corner of Route 9 and Route 3, Rosemount
23. District 197 High School, Marie Avenue and Warrior Drive, Mendota Heights
24. Edina City Hall, Minnewawa and Hopkins Roads, Edina
25. Central CISC Hub, East Bank Campus, University of Minnesota

The layout of each of the four arteries is shown on Map 1 below. In addition, the technical characteristics and cost factors of each artery are discussed in detail in the Appendix. The highest frequency (and therefore channel capacity) gradually declines in each of the four arteries. For example, in the east artery, top downstream frequency shifts from 300 MHz, to 216 MHz, to 108 MHz and finally to 72 MHz by the time the cable reaches Stillwater (CISC #1). Fortunately, the availability of channels tends to correspond roughly with population densities. St. Paul Vocational Trade School in St. Paul can thus receive as many as 25 downstream channels, while Stillwater can receive only six.

TABLE 6. NETWORK SUMMARY, OPTION II

Artery	# CISC's	# Channel Downstream	# Channel Upstream	# Miles	Cost Downstream	Cost Upstream	Total Cost
East	8	45	35	40.7	$107,600	$175,200	———
North	6	26	14	30.3	$ 55,700	$109,300	———
South	5	27	17	33.0	$ 65,600	$105,900	———
South-west	5	28	17	14.1	$ 56,300	$ 29,600	———
Totals	24	126	83	118.1	$285,200	$420,000	$705,200
Plus Central Hub CISC #25	1	+4	+2				
Less time-shared channels counted in each artery		-3	-3				
Total	25	127	82				

Map 1. OPTION II: CISC INTERCONNECTION CABLE NETWORK



1 SPRING PARK
2 ORONO
3 MINNETONKA BEACH
4 TONKA BAY
5 EXCELSIOR
6 GREENWOOD
7 WOODLAND
8 MEDICINE LAKE
9 VICTORIA
10 ROBBINSDALE
11 SPRING LAKE PARK
12 U S GOVT
13 HILLTOP
14 COLUMBIA HEIGHTS
15 ST ANTHONY
16 LAUDERDALE
17 FALCON HEIGHTS
18 MENDOTA
19 LILYDALE
20 GREY CLOUD
21 LANDFALL
22 DELLWOOD
23 PINE SPRINGS
24 MAHTOMEDI
25 GEM LAKE
26 BIRCHWOOD
27 WHITE BEAR
28 BAYPORT
29 WILLERNIE
30 OAK PARK HEIGHTS
31 LAKELAND SHORES
32 ST. MARY'S POINT

ANOKA — - — County
GRANT - - - - Township
OSSEO ——— Municipality

MASTER CONTROL CENTER OF THE CISC NETWORK

System control for the CISC network is complex, requires computer support and is exercised by two distinctly different means. First, there is a manually controlled "video switchboard" to manage video phone service. Second, there is a computer-based system which centrally controls both information display and access to the express counter and interactive terminals in each CISC. Both of these systems are based at a master control center, which, for the purposes of analysis, is presumed to be located on the East Bank Campus of the University of Minnesota, the central hub for the CISC network.

The video switchboard control system operates in a manner analogous to a commercial television network's procedures for televising live a political convention. That is, many camera displays are routed to a central control room, where a director decides which images (or combinations of images) will be shown on the broadcast.

In this case, the master control center consists of switching facilities which permit signals from any CISC (and from other separate sources of programs, such as a nearby videocassette library) to be routed to any or all other CISC's. Three kinds of switching routines are anticipated:

1) Private, Two-Party Video Telephone. Persons in the private office teleconferencing facility at one CISC see and are seen by those in the comparable facility in another CISC. This kind of switching is called "hard-wired"--that is, once the connection at the control center is established, no further human involvement is required until the teleconference

is completed. The number of simultaneous teleconferences which can take place depends upon other demands for the channel capacity of the network, but potentially there could be 12 simultaneous two-party teleconferences, using 24 video channels.

2) Private Three- or Four-Party Video Teleconferencing. Here, all upstream video signals from each of the CISC participants in the teleconference would be processed through a special effects generator at the master control center.[1] All three or four images of the parties would be displayed in quadrants of a single downstream signal sent to all four CISC's. This would also be a "hard-wired" connection, and it would be up to the participants to develop a procedure for taking turns speaking. There could be two of these conferences simultaneously, using up to 10 video channels.

3) Multiparty Audience Teleconferencing. This procedure resembles the network coverage process. Any number of CISC's might participate, each sending a signal from the audience teleconferencing studio to the master control center. There, signals are routed to a control room where a system director would select up to four of the signals for processing by a special effects generator into a single downstream signal to all downstream CISC's. The director would observe four monitors for the four selected upstream signals, a master monitor for the downstream signal and two preview monitors to examine signals he or she planned to add. An audio network permits

1 A special effects generator receives video signals from as many as four different sources and enables the user to switch, fade, dissolve, superimpose or split the signals for special effects on the transmitted signal.

the director to converse with a local director at each CISC (who must control the two cameras at the CISC studio).

The system director would thus control the viewing and speaking sequence for the entire teleconference. This system might be used for interactive instruction, high school debates, local government meetings or similar functions where audience response is an important element in the proceedings.

On the other hand, the computer-based control system for the express counter and interactive television terminals operates quite differently. Interactive television terminals involve making the televised programming appear according to the viewer's instructions. Arranging for a large number of simultaneous users to access programming on this basis necessarily involves the use of computers.[1]

In the CISC system the computer serves two purposes. First, it controls communications with each of the CISC terminals, and thereby manages the video and data traffic flow on the two time-shared channels connecting all the CISC terminals. The upstream time-shared channel carries the short digital messages from the express counter terminals and also the higher speed data stream from those interactive television terminals used for computer assisted instruction.

The downstream time-shared channel is used exclusively to send

1. It should be noted that this is a more advanced form of two-way capability than that encountered in subscriber response cable television. Subscriber response permits viewing polling, remote channel control and sensing devices in the home, but it does not permit control of programming.

digitally-encoded video frames to the express counter terminals (which are equipped, as noted earlier, with video refresh devices). The structure of the computer control program which processes the message traffic between the computer and the CISC express counter terminal was developed by the MITRE Corporation for its TICCIT system.[1]

The CISC system, however, does not depend solely upon the use of video refresh units located only at the subscriber terminals and a time-shared channel. Instead, it is a mixture of home video refresh (and a time-shared channel) and central control refresh (and a full channel for each terminal).

The express counter terminals, which are designed mainly to provide detailed visual information quickly, are most suitable, as noted earlier, for still video applications such as weather forecasts, bus routes, theatre seating availability and similar information retrieval functions. It is anticipated that each transaction will be short and self-contained. A time-shared channel for the 50 CISC express counter terminals assumes that the overall volume of use will not congest the channel, because lengthier transactions will take place on the interactive television terminals.

The interactive television terminals do not have local video refresh units and therefore do not time-share channels from the master control center to each CISC. The reason for this is that most interactive uses such

1. Technical and Economic Considerations of Interactive Television, Vol. II, February 1972, McLean, Va., MITRE Corp. The system contemplated here is a variant of MITRE's 90-port system.

as computer assisted instruction, random access to cassette libraries and, perhaps, live telecasting will not permit time-sharing of a TV channel by more than one user. Thus, there is no need for video refresh units at each terminal. Instead, the system control computer will assign a channel to a terminal user and a source of interactive programming, such as:

--A videocassette library

--A computer assisted instruction system

--A centrally located case worker for social services delivery.

In order to make channel assignments as described above, the computer would monitor the use of all channels in both directions throughout the CISC network, even though some channels would be prescheduled manually for teleconferencing.

OTHER SERVICES OF THE CISC NETWORK

Although the CISC system is intended to provide interactive television and other advanced terminal capabilities[1] to the general public, the existence of the network and its relatively ubiquitous geographic deployment make it a resource available for specialized interconnection services which do not make use of the CISC's. This would be the case particularly in early stages of the system development, when channel capacity is not likely to be fully utilized.

1. For example, the broadband network interconnecting the CISC's provides an opportunity for electronic facsimile reproduction service. It is assumed that a reader/copier could be located at each CISC. Facsimile traffic could be sent to other CISC's over the time-shared channels. High speed photocopy is, however, expensive; each terminal might cost $1,200 per month, with live charges of $1,000 per month. See Urban Cable Systems, 1972, Washington, D.C., MITRE Corp., p. 322.

Specialized closed circuit users, such as those listed in Table 2 at the conclusion of Chapter III, can be served by renting bandwidth on the CISC system to them; by constructing excess capacity at the time the CISC network is built; or by adding capacity later. The engineering design philosophy embodied here is a compromise among all three methods. Since there is no guarantee that any one or all of the users discovered in the user survey will in fact use the system, and since there are likely to be other users not yet identified, the initial construction design must represent a balance between geographically omnipresent service, excess capacity and system cost.

The CISC system, Option II, can accommodate the upstream TV channel needed to link selected public schools with the University of Minnesota Instructional Systems Resource Center, for student observation of actual teaching. It can also provide the upstream and downstream TV channels (one each way) desired for the hospital network and the closed circuit networks for the private colleges and the arts and cultural consortium.[1] These requirements can be met without unduly impairing the CISC system operations The data networks, because they involve connection to so many terminals, cannot be accommodated in a practical manner except through the distribution capabilities of a cable system, and thus are not provided by the CISC network in Option II.

The capital costs for the CISC network depend heavily upon exactly what equipment is placed in each CISC. For the sake of analysis, all CISC's

1. See Table 2 at the conclusion of Chapter III for "Category II--Closed Circuit Services."

are presumed to be identically equipped. Capital costs for Option II are shown below in Table 7.

TABLE 7. OPTION II, CAPITAL COSTS

A. Master Control Center	
1. Channel switching	
130 processors @ $1,100	$ 143,000
Patch panel	
85 RF inputs to IF to 130 RF out	10,000
Subtotal	$ 153,000
2. Audience teleconferencing equipment	
IF switching patch panel to video	$ 5,000
24 IF to video and audio demods @ $825	19,800
modulator	1,500
video switcher and special effects generator	40,000
avdo wirelock	5,000
audio switching	9,000
monitor (3 color, 4 black & white)	3,500
Subtotal	$ 83,800
3. Private video telephone equipment	
IF switching--25 channels in, 8 out	$ 7,200
8 demodulators @ $825 (less RF and IF modules)	6,600
2 modulators	3,000
2 video switchers and special effects generators	80,000
2 avdo wirelocks	10,000
Subtotal	$ 106,800
4. Terminal control[1]	
Computing (main processor and terminal processor)	$ 279,000
Audio-visual components	100,000
Supplies	20,000
Subtotal	$ 399,000
5. Construction and installation	$ 65,000
Total	$ 807,600

1. Cost figures adapted directly from MITRE, Interactive Television, pp. 97, 103, 195, 126 and 142.

B. Cable Network Distribution

1.	Downstream	$ 285,200
2.	Upstream	420,000
	Subtotal	$ 705,200

C. CISC Facilities

	Each	Total for 25 CISC's
Audience video teleconferencing studios	$ 62,800	
Private video telephone studio	7,275	
Express counter terminals	950	
Interactive television terminals	2,100	
3/4 inch color cassette recorder; 1/4 inch black and white portable recorder with cameras and time base corrector	20,300	
Renovation and installation (15%)	14,014	
Construction	5[illegible]00	
Total	$ 161,439	$4,035,975
Spare parts, test equipment and contingencies (10%)		554,878
OPTION TOTAL		$6,103,653

This system option would offer two kinds of communications services. One is the use of channel capacity in the system by closed circuit users who do not plan to use CISC's (such as the "Category II--Closed Circuit Services" users in Table 2 at the conclusion of Chapter III), but wish to use the cable network connecting the CISC's. The other is services directly related to the CISC facilities. Aside from the interconnection prices--the cost for the use of the channel capacity--there are charges related to the use of each of the categories of CISC facilities:

1) Teleconferencing

--use of audience studios

--use of private studios

2) Express counter terminals

3) Interactive television terminals

These facilities can be charged to agencies providing services or directly to users at the CISC centers. How this is arranged depends mainly upon ownership arrangements which will be discussed in Chapter V.

It should be noted that a variation of Option II might be the CISC network combined with the ITFS broadcast microwave system in Option I. The CISC's could become neighborhood centers for the local exhibition of the public programming carried by the ITFS system. Additionally, outlying cable television systems or institutional users could receive the ITFS service

OPTION III: LDS AND ITFS INTERACTIVE MICROWAVE SYSTEM

This is the first option premised upon the expectation that there will be cable service in most areas in the metropolitan region. ITFS and LDS microwave would be used to broadcast from a master switching and microwave broadcast center to each of the cable television systems in the region. In addition, microwave would carry one TV signal from any three of the 17 cable system headends to the master switching and microwave broadcast center. Three channels of common carrier microwave would bring distant independent television station signals to the microwave broadcast center, where they would be transmitted to the cable system headends.[1]

Option III can be considered the most conventional choice, a typical interconnection system for commercial cable system use. It represents a decision that public investment in a CISC system is not warranted, and that the majority of perceived public interconnection needs can be satisfied by a microwave system designed mainly to support commercially all of the metropolitan area's cable systems.

The system employs a mixed ITFS/LDS system--even though an LDS system would be less expensive for 17 cable systems--because ITFS can transmit at higher power than LDS, thus permitting extension of service to outlying rural areas at greater distances from the center of the metropolitan region.

The system would consist of a four-channel ITFS microwave system

1. It is assumed that three independent signals would provide the likely choices for all cable systems, each of which is permitted to import two signals.

similar to that described in Option I (but without audio response) plus a two-way LDS microwave system linking cable system headends to the master switching and microwave broadcast center. The LDS microwave components include twelve single-channel LDS transmitters[1] which feed signals to six directional parabolic broadcast antennas.[2] To facilitate the analysis, 17 hypothetical cable system headend locations were chosen to provide cable service to the hypothetical franchise zones provided the center by the council's Districting Subcommittee. Six microwave transmission paths will reach all 17 headends.[3]

Each cable system headend is equipped with a broadband LDS receiver capable of receiving all 39 LDS channels, and a four channel ITFS receiver/converter. In addition, each cable system headend is equipped with a directional parabolic broadcast antenna. The master switching center is equipped with an omnidirectional receiving antenna (in order to receive return signals from all cable systems) and a broadband LDS receiver.

Overall, the interconnection system includes three single-channel portable transmitters, which can be used at any of the 17 cable system headends, to activate an upstream channel back to the master switching and microwave broadcast center. Portable transmitters were selected because permanent installation of the single-channel transmitter at all 17 cable headends represented a capital cost of $172,500; but three portable units

1. Single channel transmitters give better performance for a large number of distant reception points than would a single broadband transmitter.
2. Omnidirectional antennas do not provide sufficient range.
3. The locations of these headends, together with the hypothetical franchise zones they would serve, are found in the Appendix.

(meaning that antennas, waveguides and mounting are installed at each headend; only the transmitter is moved), including a delivery vehicle, total $27,800.

Expenditure of the additional $100,000 is not warranted, given the likely volume of live cablecasting from headends which could be expected under the assumptions for this system. Further, if an operating upstream channel were to be provided from each headend, microwave would become no longer cost-effective; cable would be cheaper. This kind of design is presented in Option IV.

In addition to the receiving and transmitting electronic apparatus, the master center is equipped with switching facilities which permit an upstream signal from a cable headend to be rebroadcast on the ITFS or LDS system downstream to all other cable system headends. The capability permits live cablecasting from remote studios, such as those anticipated for the community colleges, or public access or local origination facilities at any of the cable systems. The four ITFS channels would permit the existence of regional access channels as well as distribution of University of Minnesota extension programming to all cable headends.

Unlike Option I, this option is designed mainly to support the commercial interconnection needs of the cable systems. Therefore, it does not include a major control center located on the East Bank Campus of the University of Minnesota. Instead, the switching and microwave broadcast center (located at the IDS Building) would import three distant signals and one channel of pay television programming (all four delivered to the IDS

Building by common carrier microwave); three LDS channels from cable system headends; and eight channels of educational programming from the East Bank Campus. Finally, there is capacity for the regional access channel as required by the Minnesota Cable Communications Act. Signals from the East Bank Campus are broadcast via a low-powered LDS eight-channel transmitter to the IDS Tower. Channel allocation for this system is shown in Table 8; and the capital costs of this option are shown in Table 9.

TABLE 8. CHANNEL ALLOCATIONS, OPTION III

Number of Channels	Channel Use	From	To	Via
3	Distant signal import	Other cities	IDS Building	Common carrier
1	Pay television	Other city	IDS Building	Common carrier
2	Cable headend upstream	Any cable headend	IDS Building	LDS
8	Video closed circuit upstream	East Bank Campus	IDS Building	LDS
1	Metropolitanwide access channel	Any cable headend	IDS Building	LDS
12	Video downstream	IDS Building	Cable headend	LDS
4	Video downstream	IDS Building	All	ITFS

TABLE 9. OPTION III, CAPITAL COSTS

A. IDS Tower	
4 ITFS 10-watt, transmitters	54,000
omnidirectional antenna, transmitter	3,000
12 LDS transmitters @ $7,500	90,000
8 antennas, transmit	3,000
1 LDS receiver (40-channel)	7,500
Receiving antennas	4,000
12 channel processors @ $1,100	13,200
4 modulators @ $1,400	5,600
Construction and installation	20,000
Subtotal	$ 200,300
B. East Bank Campus	
8-channel broadband transmitter	36,600
Antenna	400
Construction	4,000
Subtotal	$ 41,000
C. Reception Equipment, Cable Headends	
17 ITFS receiving antennas @ $400	6,800
17 LDS receiving antennas @ $300	5,100
17 LDS broadband receivers @ $7,500	127,500
17 ITFS receiver/downconverters @ $800	13,600
17 LDS transmit antennas, waveguide and mount @ $400	6,800
3 LDS single channel transmitters @ $7,500	22,500
Vehicle and accessories	5,300
17 Construction and installation @ $500	8,500
Subtotal	$ 196,000
Spare parts, test equipment and contingencies (10%)	$ 43,740
OPTION TOTAL	$ 481,140

This system would offer two classes of service based upon the identity of the user. ITFS service is available to institutional users, whether or not they are connected to cable systems; LDS service is available to such users only if they are connected to cable systems. Hence, the programming transmitted via ITFS can be received only by institutions (and cable systems), whereas the material transmitted via the LDS system must be delivered to cable systems for further distribution. Interactive television instruction would not be practical on a regional basis unless it took the form of ITFS voice upstream channels as outlined in Option I. Voice upstream could be provided through the ITFS system in Option III, though reception points for that class of service would be independent of cable systems.

In this system option, since it is assumed that there is insufficient interest to warrant the investment in a CISC network, there would be no demand for voice upstream capability as well. Nor would there be capacity for any of the closed circuit services in this interconnection system option.

OPTION IV: CABLE AND MICROWAVE INTERCONNECTION OF CABLE SYSTEMS

This option is a high capacity system employing cable and microwave links to interconnect 17 cable system headends with each other and with a three channel satellite network. There is sufficient channel capacity to permit a variety of closed circuit services. It is the first option capable of delivering all of the basic one-way services and the closed circuit services envisioned in Chapter III.

The system consists of three major components:

1) An ITFS microwave system delivering four channels from the master center to the 17 cable system headends and to other institutions equipped with ITFS reception equipment.

2) A dual cable network which delivers 21 common channels and 14 additional channels per artery to each cable system headend, and carries three channels from each franchise zone to the master switching center.

3) A three-channel earth receiver station to provide a link with national satellite networks.

The design of this system results from an economic cost-benefit analysis of the ability of cable--versus the several forms of microwave--to provide high capacity interconnection between the 17 cable system headends. While this kind of analysis might yeild different results in another application, here the results were:

--That microwave will deliver 15 to 20 channels to even the most distant headend at a cost significantly less than cable delivery, if the cable is not part of a dual cable system.

--That LDS microwave cannot provide more than 39 channels overall, or an average of 2.29 upstream channels per headend; while cable can provide as many as seven upstream per headend and is cost-effective in any case.

--That dual cable plant, with both upstream and downstream networks, costs less than cable and microwave combinations, and has more capacity than microwave alone.

The system is made up of three dual cable arteries connecting each of the 17 cable headends with a master switching center and satellite earth station. Both of these latter two facilities are assumed to be on the East Bank Campus of the University of Minnesota, but only to facilitate the analysis. They could be located elsewhere.

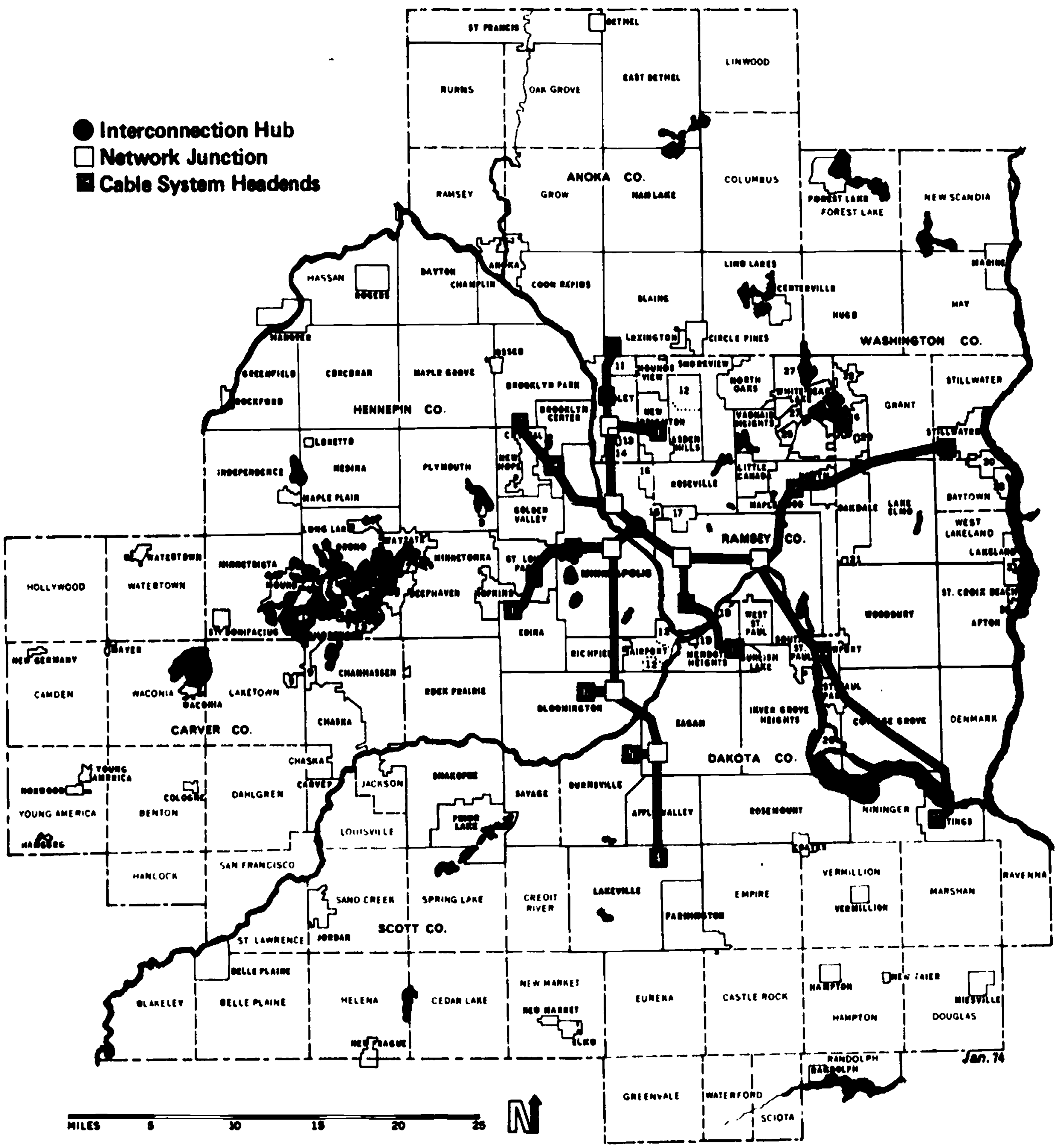
The four-channel ITFS system is included to permit microwave broadcast to outlying areas and to institutions not served by cable. The ITFS transmitter is assumed to be on top of the IDS Building.

This option does not make use of LDS microwave because at the required channel capacities, it is not cost-effective. However, LDS is an important downstream expansion resource should more capacity be needed. The link between the East Bank Campus and the IDS Building is, therefore, cable, to anticipate the high volume of traffic that would result if LDS is added later. The cable is installed at the same time as the local cable system, to take advantage of cost savings which accrue from sharing the high cost of construction.

The cable link is a 35-channel cable, with electronic one-way amplifiers installed to enable carriage of 21 signals from the East Bank Campus to the IDS Building. The electronic amplifiers for 14 channels of return communications, should upstream microwave be added, would be installed when needed.

The capacity of the three arteries is summarized in Table 10 below, and is shown in detail in Map 2.

Map 2. OPTION IV: HEADEND INTERCONNECTION CABLE NETWORK



1 SPRING PARK
2 ORONO
3 MINNETONKA BEACH
4 TONKA BAY
5 EXCELSIOR
6 GREENWOOD
7 WOODLAND
8 MEDICINE LAKE
9 VICTORIA
10 ROBBINSDALE
11 SPRING LAKE PARK
12 U. S. GOVT
13 HILLTOP
14 COLUMBIA HEIGHTS
15 ST. ANTHONY
16 LAUDERDALE
17 FALCON HEIGHTS
18 MENDOTA
19 LILYDALE
20 GREY CLOUD
21 LANDFALL
22 DELLWOOD
23 PINE SPRINGS
24 MAHTOMEDI
25 GEM LAKE
26 BIRCHWOOD
27 WHITE BEAR
28 BAYPORT
29 WILLERNIE
30 OAK PARK HEIGHTS
31 LAKELAND SHORES
32 ST. MARY'S POINT

ANOKA —— County
GRANT - - - - Township
OSMO —— Municipality

TABLE 10. NETWORK SUMMARY, OPTION IV

Artery	# Cable Headends	# Channel Downstream	# Channel Upstream	# Miles	Cost Downstream	Cost Upstream	Total Cost
East	6	38	30	57.4	$209,500	$203,100	———
North	5	35	19	25.0	$ 68,900	$ 92,200	———
South	6	35	23	32.6	$104,800	$126,900	———
Totals	17	108	72	115.0	$383,200	$422,200	$805,400
Less shared channels counted in each artery		2 x 21 = -42	2 x 3 = -6				
Totals		66	66				

Downstream channels to the cable system headends are intended mainly for mass distribution to the systems, for further distribution to subscribers. Thus, f·wer channels are dedicated than was the case in the CISC network. Here it is proposed that the four ITFS channels and 11 of the 21 cable channels carry the 15-channel, one-way programming package described in Chapter III. One channel is set aside for regional public access. Nine channels are available for commercial use by the cable system operators for such purposes as carriage of imported distant signals, satellite delivered signals or pay television channels.

In addition, 14 to 17 downstream channels per artery are available for

shared or dedicated use as needed. These channels provide downstream capacity to the specialized closed circuit users identified in Chapter III (and also served by Option II).

Upstream channels (there are three dedicated channels per headend) from each cable system headend are added to those from other headends as the cable is routed, via each of three arteries, toward the master switching center, and capacity requirements increase. Thus, the cable component is similar to the upstream cable in the CISC system (Option II), except that signals originate from cable system headends rather than CISC centers. In addition, there are initially four channels (each way) connecting the East and West Bank Campuses; and 15 channels each way between the East Bank and the St. Paul Campuses, to permit easy exchange of live programming among various University of Minnesota program sources.

This system would be capable of supporting anticipated one-way instructional television interconnection, including the 15 channels of programming set forth in Chapter III. And it has sufficient capacity to be able to provide point-to-point closed circuit service.[1] It does not permit interactive television services of the type anticipated for the CISC system, nor is it designed to provide on-demand teleconferencing.[2] It is ideally suited to facilitate extensive local program exchange, and to provide an efficient and expandable link with national satellite networks. The capital costs of the option are found in Table 11.

1. See Appendix for engineering modifications to the East Artery to accommodate closed circuit users.
2. However, teleconferencing could be set up through the cooperative effort of the cable system operators.

TABLE 11. OPTION IV, CAPITAL COSTS

A. Master Switching Center	
Satellite earth station	90,000
3 receivers @ $8,000	24,000
3 modulators @ $1,400	4,200
Switching panel (IF)	8,000
108 signal processors @ $1,100	118,800
Construction, engineering	65,000
Subtotal	$ 310,000
B. Cable Link from East Bank, University of Minnesota to IDS Building	
Cable and electronics	
35 channels--one-way electronics	8,000
Construction	43,000
Subtotal	$ 51,000
C. Microwave Broadcast--IDS Tower	
4 transmitters @ $13,500	54,000
4 demodulators @ $1,300	5,200
Antennas	7,000
Construction and renovation	5,000
Subtotal	$ 71,200
D. Cable Upstream System	
Subtotal	$ 422,200
E. Cable Downstream System	
Subtotal	$ 383,200
F. Receiving Locations--Cable Headends	
17 antennas @ $300	5,100
17 ITFS receiver/downconverters	13,600
Construction and renovation	8,500
Subtotal	$ 27,200

G. Service of Four Channels Each Way Between East and West Campus, University of Minnesota

Distance--1 mile	
Ducts for cable are available	
8 modulators @ $1,400	11,200
5,000 ft. of 0.412" cable	500
Construction	500
Subtotal	$ 12,200

H. Service of 15 Channels Each Way Between East Campus and St. Paul Campus of University of Minnesota

5 miles of 1st cable @ $3,370 per mile	17,000
5 miles of 2nd cable @ $1,600 per mile	8,000
Subtotal	$ 25,000
Spare parts, test equipment and contingencies (10%)	$ 130,200
Total	$1,432,200

OPTION V: ADVANCED CABLE AND MICROWAVE INTERCONNECTION SYSTEM FOR BOTH CABLE SYSTEMS AND CISC's

In essence, this system is a combination of Options II and IV. It incorporates the ITFS microwave system, the cable network linking 17 cable system headends and the cable network interconnecting 25 CISC's. This option is capable of meeting all of the hypothetical uses in each of the three categories discussed in Chapter III. The system puts to advantage two kinds of economies of scale:

--Lower costs for combining switching facilities, and lower construction costs for cable sharing the same routes.

--Lower service costs to closed circuit users because of the greater availability of interconnection facilities--that is, the existence of several interconnection networks means that hook-up charges are likely to be less than for systems with fewer facilities since each user is likely to be closer to interconnection facilities.

It should be emphasized that Option V represents an extraordinary level of demand for interconnection services. A decision to build such an advanced system at the onset would hardly be in the public interest unless there is hard evidence that need for it will exist in the near term. Nonetheless, Option V might well be the option that is built before the end of the next two decades.

Principally, this option is presented and developed here to illustrate how economies of scale would function, and also to define for analysis an

upper bound of technical investment beyond which any interconnection system is certain not to go. Capital costs for this option are found in Table 12, and the option is illustrated in Map 3.

SUMMARY

This chapter has attempted to demonstrate various levels of interconnection service which can be provided with existing technology. It has anticipated necessary levels of services for two cases: when there are few or no cable television systems operating in the Twin Cities metropolitan area; and when there are a number of operating systems spread across the area. In addition, these systems have been designed to meet specific, albeit hypothetical, demands for service.

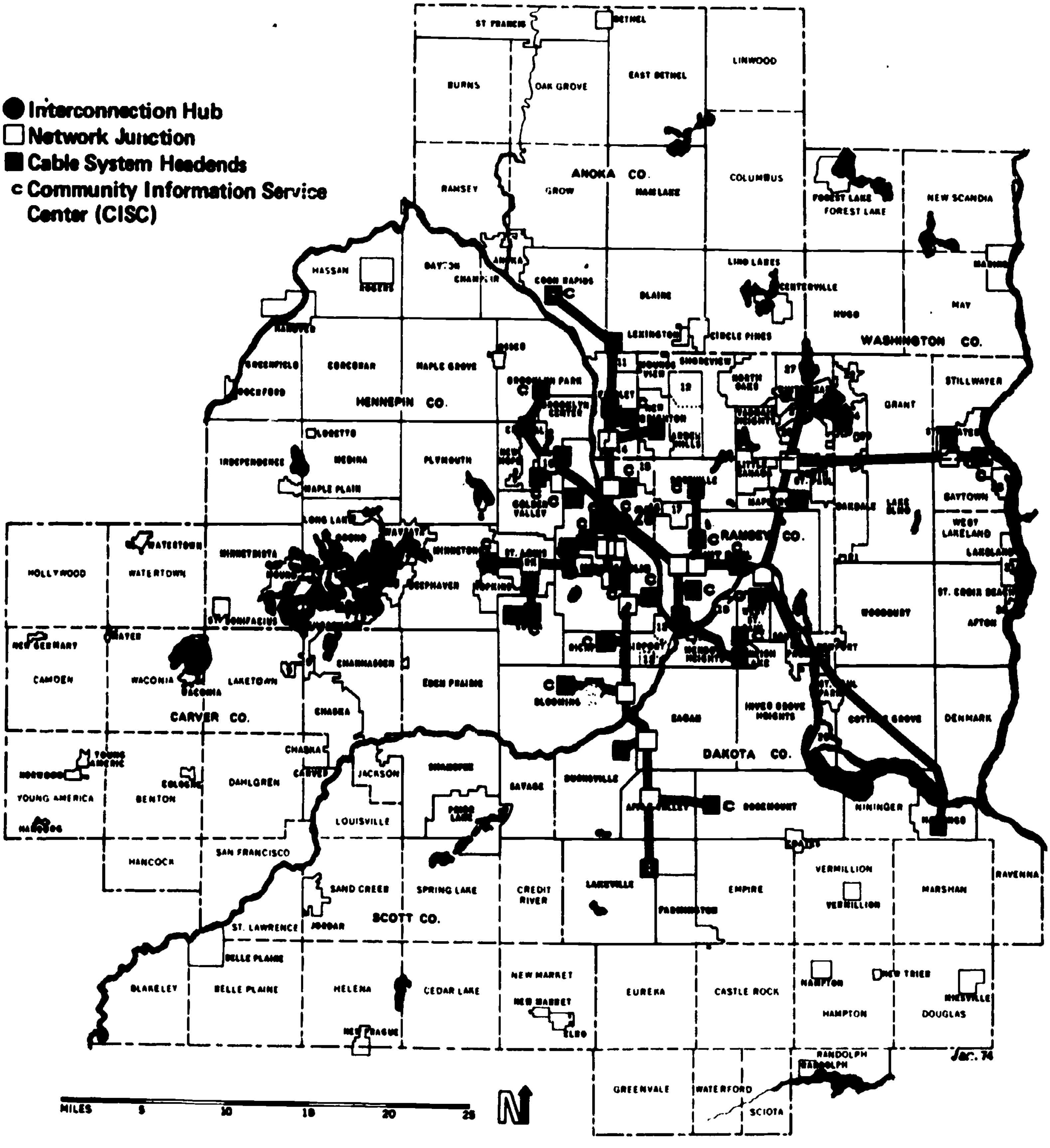
Each of the five interconnection system options is summarized in Table 13 which follows.

TABLE 12. OPTION V, CAPITAL COSTS

A. <u>Control Center</u>	
1. CISC Master Control (as in Option II)	
Teleconference control	190,600
CISC channel switching	153,000
Terminal control	399,000
Subtotal	$ 742,600
2. Cable System Master Switching Center (as in Option IV)	
Subtotal	$ 245,000
Construction and renovation	80,000
Total costs for control center	$1,067,600
B. <u>Cable Link From East Bank Campus to IDS Building</u>	
Cable and electronics for 21 channels one-way	8,000
Construction	4[illegible],000
Total	$ 51,000
C. <u>Microwave Broadcast, IDS Building</u>	
4 transmitters @ $13,500	54,000
4 demodulators @ $1,300	5,200
Antennas	7,000
Construction and renovation	5,000
Total	$ 71,200
D. <u>Cable Network</u>	$1,367,330
E. <u>Cable System Headend ITFS Reception</u>	
17 antennas	5,100
17 ITFS receiver/downstream	13,600
Construction and renovation	8,500
Total	$ 27,200
F. <u>University of Minnesota Cable Loop</u>	
East Bank and West Bank Campus Loop	12,200
East Bank and St. Paul Campus Loop	25,000
Total	$ 37,200

G. CISC Equipment	$4,035,975
Option Subtotal	$6,657,505
Spare parts, test equipment, and contingency	665,750
OPTION TOTAL	$7,323,255

Map 3. OPTION V: CISC AND HEADEND INTERCONNECTION NETWORK



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ANOKA – – – County
GRANT - - - - Township
ORONO ——— Municipality

TABLE 13. SUMMARY OF INTERCONNECTION SYSTEM OPTIONS

Option	Capital Cost	Technologies Used	Services Provided	Downstream Channels	Upstream Channels
I	$ 249,920	ITFS microwave	Televised education without cable systems	8 ITFS video	4 ITFS audio
II	$6,103,653	Two-way cable	CISC network, closed circuit users without cable systems	127 cable video video and data	82 cable video and data
III	$ 481,140	ITFS and LDS microwave	Televised education and commercial programs, with cable systems	4 ITFS video 12 LDS video	3 LDS video
IV	$1,432,200	Two-way cable and ITFS microwave	Televised education, commercial programs, closed circuit users with cable systems	66 cable video and data 4 ITFS video	66 cable video and data
V	$7,323,255	Two-way cable and ITFS microwave	Televised education, commercial programs, CISC network, closed circuit users with cable systems	193 cable video and data 4 ITFS video	148 cable video and data

TABLE 14. CAPACITY OF INTERCONNECTION SYSTEM OPTIONS TO SATISFY USE DEMANDS

USE NUMBER	CATEGORY[1] OF USE	SPONSORING AGENCY	OPTION I	OPTION II	OPTION III	OPTION IV	OPTION V
1	III	University of Minnesota (U. of M.), Continuing Education and Extension (CEE), Department of Conferences	X	X			X
2	I	U. of M., CEE, Minnesota State Bar Association	X	X	X	X	X
3	I	Minnesota Community Colleges	X	X	X	X	X
4	I	Minnesota Community Colleges		X	X	X	X
5	I	U. of M., CEE, Department of Extension Classes	X	X	X	X	X
6	III	U. of M., CEE		X			X
7	III	U. of M., Institute of Technology	X	X			X
8	I	U. of M., CEE, Woman's Program Section	X	X	X	X	X
9	II	U. of M., CEE, Division of Curriculum Education, Instructional Systems Resource Center and the Minneapolis Public Schools		X		X	X
10	I	U. of M., CEE, Department of Independent Study	X	X	X	X	X

NOTE: "X" indicates that the interconnection system option can meet the specified use.

1. Category I indicates use is a basic one-way cable use; Category II is a closed circuit use and Category III is a two-way, interactive use.

NUMBER	CATEGORY[1] OF USE	SPONSORING AGENCY	OPTION I	OPTION II	OPTION III	OPTION IV	OPTION V
11	I	U. of M., CEE, Department of Independent Study	X	X	X	X	X
12	I	U. of M., School of Dentistry	X	X	X	X	X
13	II	U. of M., Health Services Department and University Hospital		X		X	X
14	II	Augsburg College, Bethel College, College of St. Catherine, College of St. Thomas, Concordia College, Hamline University and Macalester College		X		X	X
15	I	Same as 14		X	X	X	X
16	III	U. of M., Audio-Visual Library Services (AVLS)		X			X
17	I	Same as 16	X	X	X	X	X
18	I	Same as 16	X	X	X	X	X
19	I	U. of M., CEE, Fire Service Information, Reserach and Education (F.I.R.E.) Center	X	X	X	X	X
20	III	U. of M., and the Associated Press		X			X
21	I	U. of M., Institute of Agriculture, Agricultural Extension Service	X	X	X	X	X
22	I	Same as 21	X	X	X	X	X
23	III	Same as 21		X			X

USE NUMBER	CATEGORY[1] OF USE	SPONSORING AGENCY	OPTION I	OPTION II	OPTION III	OPTION IV	OPTION V
24	I	U. of M., College of Education, Instructional Systems Resource Center	X	X	X	X	X
25	I	Minnesota State Orchestra League	X	X	X	X	X
26	I	St. Cloud State College	X	X	X	X	X
27	I	Minnesota Metropolitan State College. Winona State College, and other Minnesota State Colleges	X	X	X	X	X
28	I	Metropolitan Area Community Colleges	X	X	X	X	X
29	II	Minnesota Educational Computer Consortium				X	X
30	I	Television Services Limited			X	X	X
31	I	Metropolitan Airport Commission		X		X	X
32	I	Minnesota Student Association, University Community Video Center			X	X	X
33	III	Walker Art Center and the Institute of Art	X	X	X	X	X
34	I	Hennepin County Library	X	X	X	X	X
35	III	Minnesota Student Association and the Telecommunications Corporation		X			X
36	I	St. Paul Public Schools and the New City Schools			X	X	X
37	III	University Community Video Center		X			X

USE NUMBER	CATEGORY[1] OF USE	SPONSORING AGENCY	OPTION I	OPTION II	OPTION III	OPTION IV	OPTION V
38	II	Walker Art Center, Institute of Art, Minneapolis College of Art and Design, St. Paul Arts and Sciences Center		X		X	X
39	III	Guthrie Theatre and other metropolitan area theaters		X			X
40	I	Archdiocese of St. Paul-Minneapolis, Communication Offices, Education Center and Catholic Welfare and Charities	X	X	X	X	X
41	I	University Community Video Center and Community Video Center - Minneapolis, Inc.			X	X	X
42	II	Gambles, Inc.		X		X	X
43	II	Metropolitanwide Computer Users				X	X
44	I	Northwestern Bank Corporation	X	X	X	X	X
45	I	Minnesota Mining and Manufacturing Corp.				X	X
46	II	Control Data Corporation		X		X	X

V. SYSTEMS ANALYSIS

This chapter subjects each of the five system option prototypes defined in Chapter IV to financial analysis. The chapter is divided into two sections. First, there is a discussion of the economic model used; the assumptions which constitute the foundation of the analysis; and the techniques of financial operation assumed to be involved in interconnection. Second, there is a summary of the results of the financial analysis, including price schedules, for each of the system options.

Those who do not wish to explore the analytical concepts in detail may proceed directly to page 113, where the price schedules for the interconnection system options begin.

THE ECONOMIC MODEL, CALCULATION OF HOOK-UP CHARGES AND ASSUMPTIONS OF ANALYSIS

In this section, the economic model is described, its terms are defined and the assumptions it makes in calculating prices are discussed. In addition, there is discussion and analysis of the way in which it is assumed that costs and revenue are allocated among interconnection system operators and other providers of communications, as a basis for calculating the full financial impact of using each of the system options.

THE ECONOMIC MODEL

To facilitate the financial analysis, the center developed a computer-based economic model which is called the Interconnection Tariff model.

It should be emphasized that the tariff model does not estimate future economic feasibility of a system as does the center's economic model for cable systems.[1] This is because the tariff model does not predict demand; demand is assumed to be at a level sufficient to guarantee a specified return on investment. This is an important qualification; it means that the model will always show the interconnection system to be financially successful. The reason for this is two-fold:

1) There is no reliable way to estimate demand for interconnection services; and financial viability prediction would be misleading.

2) The purpose of the analysis is to explore how a system might work, and to estimate the prices it would have to charge, as a foundation for further analysis and planning which will lay the groundwork for a more thorough estimate of demand.

The tariff model is a discounted cash flow model--that is it estimates costs and revenues over a 10-year period, and determines the value today of those future streams of net revenues required to meet a specified return on overall investment. The model then translates this flow of required revenues into a schedule of prices for interconnection services (dollars per channel per mile per month, or dollars per channel per hour), based upon assumed levels of demand for the systems' capacity. After the basic cost and revenue structures have been determined, the model then incorporates financing and ownership assumptions into its calculations, and develops

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1. See "Alternatives for Cable Television," 1974, Washington, D. C., Cable Television Information Center.

pro forma financial statements which illustrate the projected financial operation of the interconnection system over 10 years.

The calculating procedures in the model have two important financial characteristics which affect the price or tariff structures generated by it:

1) The model fully allocates costs among users. That is, it treats all customers equally in charging them to recover the costs of building and operating the entire system. This method is in contrast to a variety of marginal cost allocation procedures in which users who subscribe to the system after it has been in operation, or who subscribe to a new class of services, pay only the incremental cost of being added to the system (a cost normally less than their fully allocated share of total costs). The reason for using this method is that it avoids fairness questions about which customers should pay full costs and which customers should pay marginal, or incremental, costs.

2) The model calculates return on investment against a planning horizon (e.g., 10 years). This method is in contrast to the annual net income accounting method routinely applied in public utility regulation in which all costs incurred in a given year must be recovered in that year. The latter method means that the system cannot operate at a loss in its early years, despite the capital-intensive nature of the enterprise. In turn, prices must be high in early years. The planning horizon method of accounting permits the system to operate initially at a loss (as is typically done, for example, with cable systems), and allows a pricing policy which does not unfairly penalize early users of the system.

Both of these procedures are in accordance with modern accounting procedures, though not necessarily with traditional public utility methods.

The mathematical formulation of the tariff model and a precise definition of its terms are discussed in full in the Appendix.[1]

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1. It may be helpful to those not familiar with financial accounting methods to define some of the key terms used in this chapter:

   Capital expenditures. These are expenditures for equipment and construction. The total is the sum required to construct the system.

   Revenues. This is the income the interconnection operator receives for leasing the system's upstream and downstream channel capacity to users.

   Operating expenses. These are the costs associated with the operation and management of the interconnection system.

   Franchise fee. It is assumed that the system could be required in some cases to pay a franchise fee--likely to be a percentage of total revenues--to local governments.

   Depreciation. Depreciation is an accounting concept that distributes the cost of tangible capital assets over the estimated useful life of the unit in a systematic and rational manner, thus allowing for future replacement of equipment.

   Net income before tax. This is total revenue less operating expenses and depreciation.

   Net income. This is total revenue less operating expenses, depreciation and taxes

   Cash available to system owners by year-end. This is net income plus depreciation less capital expenditures; it is, in effect, "in hand" working capital.

   Required investment. This is the total amount of cash required to construct and operate the interconnection system until it breaks even. It may be more or less than capital investment (some of which may be paid for revenues), depending upon operating expenses and the flow of revenues. Required investment must be raised either from equity (the owner's cash contribution) or from debt (funds borrowed from a financial institution).

   Target rate of return. This is the assumed return to investment; it is a measure of the "interest" that would accrue to a businessperson who lent from his or her funds an amount equal to required investment. Debt/equity ratio and interest rate are not assumed here, since return to equity is not calculated.

CALCULATION OF HOOK-UP CHARGES

The tariff model does not calculate the cost of providing a link from the user's facilities to the nearest interconnection system facility. A transportation analogy may demonstrate this point. The interconnection system could be considered analogous to a commuter train. The tariff model calculates the equivalent of the train ticket, but not the equivalent of the cost of the feeder bus ticket which connects an outlying suburban community with the train station.

In mathematical terms, the tariff model is capable of computing both "commuter train" and "feeder bus" costs by allocating the cost for the link to a new customer among all existing customers--in accordance with the pricing philosophy outlined above. There are two reasons for not doing so, however. First, in Options III, IV and V, the existence of cable systems is postulated, and cable systems would provide the "feeder bus" or hook-up service. But in Option II, it is assumed that there are no cable systems, and the hook-up service would have to be provided by the interconnection operator. Unless that service is priced separately, comparison of the options would be difficult and the hook-up charges in Options III, IV and V would not be revealed.[1]

Second, if hook-up charges are routinely calculated within the interconnection tariff model, then the size of those charges and the extent to which the interconnection system is required to provide a hook-up to anyone

1. There are no hook-up charges for Option I since it only uses microwave.

at average (i.e., the same) charges become very difficult matters of regulatory policy. While the choice of method for calculating the hook-up charge does not obviate the problem of arbitrariness that is necessarily involved with the physical location of the interconnection system, the financial impact of that location on hook-up charges becomes clearer when they are calculated separately. [1]

To forecast hook-up costs, since they will be substantial for some users, a simple mathematical model has been created to estimate the price a user would be charged--either by a cable system or by the interconnection system--for the link between the user's facilities and the interconnection facilities. [2] It translates capital and operating costs for installation of cable into an annual lease charge per channel-mile of cable. The result is a formula which calculates a fixed annual charge and a charge that varies with the number of miles between the user's facilities and

1. More specifically, if the cost of the new link is substantially more than the average cost of existing links, then prices will go up for all users. Thus, for Option II, where the cable network is "thin" geographically (that is, it does not reach everywhere in the service area), hook-up charges for most closed circuit users would be expensive. The fact that a network is geographically thin makes the fairness of its layout of critical importance. Locating a control center or microwave broadcast facility in the geographic center of a region is obviously defensible for microwave networks, and for those who must deliver signals upstream. But the layout and route of each cable artery, even if engineered efficiently, is arbitrary in terms of which customers are passed and which are not (and therefore, who does and does not pay expensive hook-up charges).

   In Option II, the layout deliberately services the CISC's; in Option IV, the cable system headends. Both networks provide, to a degree, geographically even coverage, but each, in effect, subsidizes its main customers (i.e., those customers which are located along the cable paths connecting the CISC's and the headends).
2. Another method of determining the hook-up charges for the options where cable systems exist would be to allow the local government or group of local governments which is the franchising authority to establish a flat rate rather than a mileage rate for the hook-up within its franchise zone.

the interconnection system. The formulas for the annual cost of hook-up service provided by the interconnection operator (Option II) and a cable television operator (Options III through V) are, respectively:

(Interconnection Operator)

Hook-up charge = \$1,736 + \$448 x (number of miles)

(Cable System Operator)

Hook-up charge = \$1,736 + \$52 x (number of miles)

The difference between the two charges rests in the fact that the cable system operator has cable installed and need only rent bandwidth or capacity on it, while the interconnection operator must install a cable for the customer's use.[1]

---

1. The mathematical construction of the model is as follows: First, the capital expenditures related to the installation of cable and other facilities are estimated and converted to an annual charge:

a) To connect the user, a modulator, filter tap and subscriber drop cable must be installed for each connection; they are assumed here for both applications to total \$3,000 per channel at each connection.

b) A share of each mile of cable used for the link should be charged to the user. As an example, for the cable operator with a 30-channel system (and available for lease to other users), a fair charge per channel would be the cost per mile of installed bidirectional cable (assumed to be \$11,000) divided by the cable system's channel capacity. The cost would be:

$$\frac{\$11,000 \text{ per mile}}{30 \text{ channels}} = \$367 \text{ per mile}$$

For the interconnection operator who installed a cable specifically for the user, there would be few prospects for leasing channels to others, so the entire cost would be charged to the new user. Here, the cost for a 15-channel (108 MHz), 1/2 inch cable is assumed to be \$3,200 per mile with aerial construction.

Thus, total capital costs per channel at each connection would be the sum of the capital expenditures plus the product of the cost per mile times the number of miles:

Cable System	Interconnection System
\$3,000 + \$367 x (number of miles)	\$3,000 + \$3,200 x (number of miles)

These charges are applied to each of the closed circuit users of the system and are compiled in the Appendix. To illustrate in the text the impact of these charges, they are calculated in Options II, IV and V for the network of the seven private colleges (see Use #33 at the conclusion of Chapter III).

It should be noted again that there is no entirely satisfactory way to eliminate these problems of fairness. Users whose facilities are distant from an Option II interconnection route will likely wish that the arteries

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c) Conversion of the capital cost to an annual charge involves a depreciation charge and a return on the funds invested in the capital expenditures (see "e," below). Depreciation is calculated here on a 10-year, straight line basis. The annual depreciation charge would there be 1/10th of the total:

Cable System	Interconnection System
\$300 + \$37 x (number of miles)	\$300 + \$320 x (number of miles)

d) Operating costs which can be fairly attributed to the new cable link should be limited to power, maintenance and bookkeeping costs. Here, they are assumed identical for both types of systems, and are:

Power	\$ 30 per year
Maintenance	500
Bookkeeping	400
Total	\$940 per year

e) Interest charges for debt, taxes and profit are subsumed under a surcharge, here assumed to be 40% of annual capital costs and annual operating costs, (40% of \$300 + 940 = \$496; 40% of \$37 and \$320 each = \$15 and \$128 respectively), or:

Cable System	Interconnection System
\$496 + \$15 x (number of miles)	\$496 + \$128 x (number of miles)

The total annual lease charge per mile per channel for each connection becomes:

Cable System	Interconnection System
\$300 + \$ 37 x (number of miles)	\$300 + \$320 x (number of miles)
\$940	\$940
\$496 + \$ 15 x (number of miles)	\$496 + \$128 x (number of miles)
\$1,736 + \$ 52 x (number of miles)	\$1,736 + \$448 x (number of miles)

pass near them, or that hook-up costs be fully allocated among all users; and those users who are passed by an Option II artery will probably suggest that each user pay the full cost of hooking-up. In Options IV and V, where cable systems provide hook-up and access to the interconnection system via the nearest cable system headend, users will presumably press to have a cable system headend located near their facilities.

ANALYTICAL ASSUMPTIONS

In addition to the assumptions built into the structure of the economic model and the model for calculating hook-up charges, there are other analytical assumptions which relate to financing the interconnection system, levels of user demand and the financial operation of the CISC's. In this section these assumptions are discussed.

OWNERSHIP ASSUMPTION

Ownership and management issues are more important for an interconnection system than they are for other public services such as a toll highway or a sewer system, because matters of censorship and access to the media are involved. However, the nature of these issues and what must be done to resolve them are more thoroughly understood than in the case of ownership of a cable television system, for example, where public versus private ownership remains a matter of continuing controversy. Moreover, the interconnection system is likely to be regulated by the Federal Communications Commission. For these reasons, a detailed discussion of ownership issues is not carried out in this report.[1]

1. Ownership, financing and management choices in the case of intercon-

However, there must be assumptions made about ownership to permit financial analysis. Here, two major assumptions are made.

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nection options have more sharply defined and estimatable consequences than is the case with cable television franchising, where the issues of public ownership, financing and management remain ones based more upon philosophy than on hard evidence. Private financing of the interconnection systems could be accomplished by conventional combinations of debt and equity; public financing by tax-exempt bonds or by a special tax fund. Generally speaking, private financing would lead either to private or mixed public-private ownership, while public financing would lead either to public or mixed ownership. One exception is that public financing (up to a $5 million limit imposed by the Internal Revenue Service) by industrial development bonds could ultimately lead to private ownership.

Whether public or private (or perhaps a combination of the two), which funding is used to build any of the interconnection systems is a question that is largely controlled by the nature of the services offered by the interconnection system. For example, the CISC company (Option II) is not likely to be privately financed since most of its services are presently expected to be public ones. Thus, it is equally unlikely that the option would be implemented under private ownership, assuming the service remains predominantly public. Should the nature of the services (i.e., commercial versus noncommercial or public) to be offered by any of the interconnection system options vary from those summarized in Table 14 at the end of Chapter IV, an analysis of the financial and ownership questions may need to be undertaken. For the present, the following two tables illustrate the likely combinations of ownership and management for the five interconnection system options financed either with public funds or with private funds:

PRIVATE FUNDING

	Ownership		
	Private	Public	Mixed
Management			
Private	Possible for Options III and IV	Unlikely	Possible for Options III, IV and V
Public	Unlikely	Unlikely	Unlikely
Mixed	Possible for Option V	Unlikely	Possible for Options II, III, IV and V

First, it is assumed in the analysis that operation in all five options includes neither television program production, exhibition and sale, nor computer program creation and marketing. The reasons for this assumption are three fold. Analytically, it permits isolation of the cost of communications (the charge assessed for using channel or microwave capacity) from other costs in such enterprises as televised education and cassette library dial access. It also permits a rigorous look at interconnection as a self-supporting service, so that the implications of a decision to provide interconnection services independently of cable system operation is clear. And most importantly, it permits analysis of interconnection as a common carrier service--as it will almost certainly be viewed (and therefore regulated) by the FCC.

A second major assumption is that, regardless of the mode of ownership and management chosen (see "Analytical Results," below), the operation of the CISC cable network in Options II and V would be separate from the operation of the CISC facilities themselves. That is, the CISC company,

PUBLIC FUNDING

	Ownership		
Management	Private	Public	Mixed
Private	Possible for all options using industrial development bonds	Possible for Options I, II, III and V	Possible for Options II, III and V
Public	Unlikely	Possible for Options I and II	Unlikely
Mixed	Unlikely	Possible for Options I, II, III and V	Possible for Options II, III or V

which would own the 25 CISC's and the CISC computer control facilities at the master control center, would rent from an interconnection network the channels needed to interconrect the CISC's. This is, in part, an assumption of convenience, since it permits analysis of the costs of video telephone and CISC terminal services separately from the leasing of bandwidth on the CISC cable network. But, more importantly, this separation of ownership--with regard to CISC terminals--is in accordance with FCC policy.[1]

FINANCING ASSUMPTIONS

Two kinds of financing are assumed for each interconnection system option. The first illustrates very favorable financing conditions, while the second demonstrates more conventional terms. These are:

PUBLIC FINANCING (hereinafter called MUNICIPAL). It is assumed that a suitable return on investment would be a representative bond yield from a revenue bond, or seven per cent; and that no sales, property or corporate income tax, or franchise fee would be paid.

PRIVATE RISK FINANCING (hereinafter called CORPORATE). It is assumed that a suitable return on investment might have to be as high as 15 per cent, and that sales, property and corporate income taxes, as well as a three per cent (of gross revenues) franchise fee is charged to the interconnection system.

1. See, for example, GTE Service Corp. v. FCC, 474 F 2d 724 (2d Cir. 1973).

ASSUMPTIONS ABOUT NETWORK DEMAND

In Chapter IV, designs were executed to ensure that capacity was available to each CISC or cable system headend, and to potential users identified in Chapter III. It would be unrealistic to assume, however, that users would lease all of the design capacity. Assumptions must be made about how much of the design capacity is actually consumed. These assumptions are critical in that they stipulate how much of the system is successfully marketed, and therefore what prices are. Later in this chapter, the implications of changes in demand are explored.

The assumed full-time level of demand for each option is as shown in Table 15 below (these figures do not include closed circuit users, for whom capacity has been designed and accounted for in the tariff model).

TABLE 15. DEMAND ASSUMPTIONS[1]

Option	User	Purpose	Number of Channels
I	Educational users[2]	One-way downstream	6
	Others	Part-time downstream	1
	Educational users[2]	One-way audio upstream	3
	Others	Part-time audio upstream	1

SUMMARY

	Downstream	Upstream
Used	7 channels	4 channels
Excess	1 channel	0 channels

1. In each option, one upstream and one downstream channel is assumed to be consumed by part-time users.
2. Refers to the educational institutions or their branches which expressed interest in using the system. This includes the University of Minnesota (all departments), Minnesota Community College, the consortium of seven private colleges, St. Cloud State College, Minnesota Metropolitan State College, Hennepin County Library, University Community Video Center, St. Paul Public Schools and New City Schools and Archdiocese of St. Paul-Minneapolis. See Table 2 at conclusion of Chapter III.

Option	User	Purpose	Number of Channels
II	CISC's	Dedicated, downstream	4/CISC
	CISC's	Time-shared downstream	1/artery
	CISC's	Party-line downstream	1
	CISC's	Dedicated, upstream	1/CISC
	CISC's	Time-shared upstream	1/artery

SUMMARY		
	Downstream	Upstream
Used	4 dedicated/CISC 2 shared	1 dedicated/CISC channel 1 shared/artery
Excess	0 channels	1 dedicated/CISC channel

III	Public program sources	Downstream	7
	Cable systems	Distant signals downstream	3
	Cable systems	Pay television downstream	1
	Cable systems	Access channel downstream	1
	Others	Part-time downstream	1
	Cable systems	Access channel upstream	1
	Others	Part-time, upstream	1

SUMMARY		
	Downstream	Upstream
Used	14 channels	2 channels
Excess	2 channels	1 channel

Option	User	Purpose	Number of Channels
IV	Public program sources	ITFS downstream	4
	Public program sources	Downstream	11
	Cable systems	Satellite downstream	3
	Cable systems	Distant signal downstream	3
	Cable systems	Access channel downstream	1
	State computer consortium	Data channel downstream	1/2
	Others	Part-time uses downstream	1
	Cable systems	Access channel upstream	1
	Others	Part-time uses upstream	1
	State computer consortium	Data channel upstream	1/2

SUMMARY

	Downstream	Upstream
Used	19 1/2 on cable 23 1/2 total	2 1/2 channels
Excess	2 dedicated per franchise zone	1/2 per artery 3 dedicated per franchise zone

V	(Same as II and IV, combined)

It should be noted that little excess capacity is built into Options I and III, because they are microwave systems in which new capacity can be added incrementally at any time. In the cable options, excess capacity added later costs more because full construction costs must be paid, and because cable capacity comes in blocks of channels. In Option II, the excess network capacity is leased by the CISC company, since it must ensure that there be large amounts of capacity available for peak hour use to avoid a "busy signal" pattern in the availability of CISC facilities.

ASSUMPTIONS ABOUT CISC OPERATIONS

Since it was deemed important to know what prices would be necessary to make the CISC operation viable, the tariff model was modified to estimate prices users would have to pay for CISC services. As was noted earlier, it has been assumed for the purposes of the analysis that the CISC company would operate independently of the CISC cable network. Aside from regulatory considerations noted above, such an assumption permits costs to be allocated precisely and clearly among the different services.

In options with CISC operations, cost allocation has an enormous impact on interconnection prices. If, for example, in Option II, the CISC cable network and switching costs (approximately $850,000) were combined with the CISC and control center facilities costs (approximately $4.6 million), for the purpose of calculating charges for use of the cable network, prices would increase fivefold. The interconnection system would thereby clearly subsidize the CISC operation.

Here, it is assumed instead that the CISC enterprise leases needed channels from a common carrier interconnection network (which also leases bandwidth to closed circuit users--its other major customers). The CISC enterprise in turn treats the charges it pays to lease the channels it uses as an operating cost, which is incorporated into the financial operation of the CISC's. In this fashion, the CISC terminal, switching and computer costs (which considerably exceed the cost of the communications facilities) can be charged to CISC users, rather than to all interconnection users.

The modified tariff model allocates CISC capital and operating costs (including interconnection charges) between two categories of services, as follows:[1]

1) Video telephone and audience teleconferencing

2) Express counter and interactive television terminals

The model calculates prices as dollars per hour of use of the two categories of services.

It is also assumed, as noted earlier, that the CISC company leases its channels full-time from the interconnection company; however, use of the CISC facilities themselves would be of course occasional. Assumed use rates for CISC equipment are as shown below in Table 16.

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1. The communications charges are apportioned 28.1 per cent to video telephone and teleconferencing, and 71.9 per cent to terminals. These figures reflect channel use apportioned to the two types of services.

TABLE 16. CISC WEEKLY UTILIZATION RATES

Audience Teleconferencing	20 hours per week per CISC
Private Video Telephone	30 hours per week per CISC
Express Counter Terminals	20 hours per week per terminal or 40 hours per week per CISC
Interactive Television Terminals	30 hours per week per terminal or 120 hours per week per CISC

ASSUMPTIONS ABOUT THE USE OF AIR LINE DISTANCE

The tariff model calculates prices for cable network use on the basis of miles of system capacity consumed by a particular user per channel per year. It has been programmed to calculate those miles on an airline distance basis rather than by measuring actual system miles. For users with three or more points, the distance calculated is the shortest total air distance to connect all points.

This assumption has the effect of treating all users of the system fairly with regard to use of the system. Charges are based upon how far the user's facilities are from one another--not on how far the user's facilities are from other users, or from the master control center. The assumption is consistent with the fairness theory of fully allocated costs noted earlier.

DEMAND GROWTH ASSUMPTIONS

A critical set of assumptions are those which deal with how quickly the system is constructed (and paid for) as compared to how fast demand for service (and revenue) grows. To provide a "best case" and "worst case"

method of analyzing the effect of these assumptions, two assumptions about the growth of demand are postulated.

First, construction is assumed to be carried out on a turnkey basis-- that is, the system is constructed and ready to operate when it is paid for. It is also assumed that demand (at the levels established earlier in this section) would be established by the time the system is energized.

This assumption provides the base case for analysis. It is called the "Turnkey Case," and is considered to offer the most favorable financial circumstances for operating of the networks.

Second, for the purposes of sensitivity analysis, an alternate situation, identified as the "Slow Growth Case," is hypothesized. Here, it is assumed that the system is turned on (as in the turnkey case), but growth of demand takes place slowly over time. Specifically, it is assumed that demand grows as follows:

Year	1	2	3	4	5	6+
Percent of Final System Demand	10	20	40	90	100	100

This case is financially unfavorable and is presented to show the impact on interconnection prices if demand lags seriously behind system construction.

For the CISC company, it is further hypothesized that, since demand for the use of the facilities is difficult to predict, several levels of demand should be analyzed. Demand levels 10 per cent, 20 per cent, and 30 per cent above and below the base case are examined to see the effects of under- or overestimation of demand.

These assumptions constitute the most important financial assumptions used in the analysis. A more detailed set of model assumptions may be found in the Appendix.

ANALYTICAL RESULTS

In this section of Chapter V, the results of the financial analysis are summarized and evaluated.

The economic model was used to calculate prices for each design option (I-V) under four different sets of conditions (see Cases #1-20 below). In addition, the CISC company, which owns the 25 CISC's and their computer control facilities at the master control center, was analyzed separately as a public entity leasing channels from a network company (see Cases #21-24 below). The list of cases is as follows:

Case 1:	Option I (Corporate) Turnkey Case
Case 2:	Option I (Corporate) Slow Growth Case
Case 3:	Option I (Municipal) Turnkey Case
Case 4:	Option I (Municipal) Slow Growth Case
Case 5:	Option II (Corporate) Turnkey Case
Case 6:	Option II (Corporate) Slow Growth Case
Case 7:	Option II (Municipal) Turnkey Case
Case 8:	Option II (Municipal) Slow Growth Case
Case 9:	Option III (Corporate) Turnkey Case
Case 10:	Option III (Corporate) Slow Growth Case
Case 11:	Option III (Municipal) Turnkey Case

Case 12:	Option III (Municipal) Slow Growth Case
Case 13:	Option IV (Corporate) Turnkey Case
Case 14:	Option IV (Corporate) Slow Growth Case
Case 15:	Option IV (Municipal) Turnkey Case
Case 16:	Option IV (Municipal) Slow Growth Case
Case 17:	Option V (Corporate) Turnkey Case
Case 18:	Option V (Corporate) Slow Growth Case
Case 19:	Option V (Municipal) Turnkey Case
Case 20:	Option V (Municipal) Slow Growth Case
Case 21:	CISC Municipal Operation, Option II, Case 5
Case 22:	CISC Municipal Operation, Option II, Case 7
Case 23:	CISC Municipal Operation, Option V, Case 17
Case 24:	CISC Municipal Operation, Option V, Case 19

Summaries of these 24 cases, and an evaluation of the results of the analysis are presented as follows:

Options I and III. The microwave options are evaluated together.

Options II, IV and V. The cable options are examined together (excluding the operations of the CISC company).

The CISC company is examined.

The complete set of pro forma financial statements for each of the above cases is included in the Appendix.

OPTIONS I AND III – INTERCONNECTION PRICES

Microwave service costs do not vary according to distance (providing the points to be interconnected are within range of the microwave trans-

mitter, as they are in both Options I and III). For this reason, a price which varies with the number of miles between interconnection points is meaningless. Instead, the service is priced for a channel over a period of time--here, on the basis of a channel per year, as shown in Table 17 below.

TABLE 17. INTERCONNECTION PRICES, OPTIONS I AND III

Case	Option	Downstream ($)	Upstream ($)
1.	I (Corporate) Turnkey Case	14,594/ch. year	2,332/ch. year
2.	I (Corporate) Slow Growth Case	18,119/ch. year	2,895/ch. year
3.	I (Municipal) Turnkey Case	13,087/ch. year	2,091/ch. year
4.	I (Municipal) Slow Growth Case	19,156/ch. year	3,061/ch. year
9.	III (Corporate) Turnkey Case	14,912/ch. year	5.302/ch. year
10.	III (Corporate) Slow Growth Case	18,515/ch. year	6,583/ch. year
11.	III (Municipal) Turnkey Case	13,406/ch. year	4,767/ch. year
12.	III (Municipal) Slow Growth Case	19,623/ch. year	6,977/ch. year

From these results, several observations can be made. First, although the price variance between Options I and III would seem to indicate that there are no economies of scale, Option I prices do not account for the ITFS receivers, which would total $1, 700 at each location. Option III does include the cost of reception facilities at 17 cable system headends. If the equivalent of these costs were added to Option I costs (a theoretical addition, since without cable systems, it is not possible to know how many receivers

there would be), prices would undoubtedly rise.[1]

Next, the voice upstream prices (which do not include the $1,875 capital cost for the ITFS transmitter) indicate that there will not be significant differences between Option I rates for that service and rates that would be charged by Northwestern Bell for leased telephone lines.

Finally, municipal bond financing becomes far less attractive if demand lags, as is postulated in the Slow Growth cases. Corporate prices rise 24 per cent in the Slow Growth case, while municipal prices rise 46 per cent, and exceed corporate prices. The reason for this is that there are no tax benefits which help cover operating losses in the early years of the system operation under municipal financing. Income taxes restrict profitability, but they also act to buffer a corporation somewhat from financial losses. In short, under municipal financing the systems do better in good years, worse in bad years.

These figures do not provide a clear economic basis for choosing between Options I and III. They do indicate that there is little cost difference in downstream usage between the two options. This means that the decision between choosing Option I and Option III can be made without fear of penalizing the users of downstream capacity.

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1. For example, the cost of ITFS receivers for the 17 cable headends is $28,900 (17 x $1,700). This is the equivalent of 12 per cent of the capital costs for Option I (see Table 4 in Chapter IV). Thus it is reasonable to expect that unit costs will rise as the receiver costs are built into Option I.

OPTIONS II, IV AND V — INTERCONNECTION PRICES

These three options each include a cable network, and prices are calculated in dollars per channel-mile per year. The total charge for a user would depend upon the number of miles of the system's capacity used, and the specific hook-up charge for the user. In Options IV and V, the systems include microwave, but downstream prices are calculated in such a fashion that the user is indifferent to the matter of which technology is used to carry his or her signals--that is, the price is the same whether signals are carried by cable or microwave.

In order to provide a basis for comparing the cost of delivering a signal by microwave in Options I and III with the costs of delivering a signal --by whatever means--in Options IV and V, to all cable headends, a "microwave equivalent" charge is computed by multiplying the cost per channel-mile for downstream times the total air miles for the cable headend network (95.57 miles), yielding a price in dollars per channel-year. The price schedules for Options II, IV and V are shown in Table 18 below.

TABLE 18. INTERCONNECTION PRICES, OPTIONS II, IV AND V

Case #	Option	Downstream ch. mile ($)	Upstream ch. mile ($)	Microwave Equivalent ch. ($) year
5.	II (Corporate) Turnkey Case	348	718	———
6.	II (Corporate) Slow Growth Case	432	891	———
7.	II (Municipal) Turnkey Case	314	647	———
8.	II (Municipal) Slow Growth Case	459	947	———
13.	IV (Corporate) Turnkey Case	219	563	20,930

Case #	Option	Downstream ch. mile ($)	Upstream ch. mile ($)	Microwave Equivalent ch. ($) mile
14.	IV (Corporate) Slow Growth Case	272	699	25,995
15.	IV (Municipal) Turnkey Case	199	512	19,018
16.	IV (Municipal) Slow Growth Case	292	749	27,906
17.	V (Corporate) Turnkey Case	237	522	22,650
18.	V (Corporate) Slow Growth Case	294	648	28,096
19.	V (Municipal) Turnkey Case	216	476	20,643
20.	V (Municipal) Slow Growth Case	316	697	30,200

Several conclusions can be drawn from this table. First, the cost of the CISC cable network is significantly higher per channel-mile than the cable system headend network. The reason for this is that the CISC cable network (Option II) more nearly resembles a point-to-point network (like the telephone network) than does the cable headend network (Option IV)--that is, the CISC network is capable of delivering to all the CISC locations a greater variety of signals than the cable headend network is capable of delivering to cable headends.[1]

Second, there are significant economies of scale operating between Option V (the combination of Options II and IV) and Option II, as would be expected. There are also economies of scale operating between Options IV and V, even though the prices in the table above do not demonstrate this. The savings result in part from shared control facilities, but mainly from

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1. Compare downstream channel capacities for Options II and IV in Tables 6 and 10 in Chapter IV.

lower average construction costs when all of the cables are installed along the same routes at the same time. These economies of scale, however, are offset by the high cost of the CISC cable network.

Third, the "microwave equivalent" prices in Options IV and V are greater than the downstream price for Options I and III (in which signals are carried by microwave). This is not due to an inherent cost-effectiveness of microwave downstream (if such had been the case Options IV and V would have been designed to use microwave downstream more extensively). It merely reflects the added cost of sophisticated control center equipment, including switching capacity and the satellite earth station.

The impact of these prices may be clearer if they are applied to representative users. For this purpose, three users are used as examples:

--Educational users, who program seven channels downstream[1]

--The three-channel closed circuit network linking the seven private colleges

--The CISC company, which leases four channels downstream and one upstream per CISC and one channel per artery downstream and upstream.

The total annual communications bill for each of these users, which includes both the interconnection charge and the hook-up charge (where applicable) for each of the options capable of serving them, is shown in Table 19 below. Note that only "Turnkey" cases are shown; "Slow Growth" prices would be higher.

Hook-up charges were calculated in accordance with the procedures outlined earlier in this chapter,[2] and distances were measured between

1. Seven channels permits comparison with Options I and III.
2. See footnote 1 on page 100.

TABLE 1[illegible]. ANNUAL INTERCONNECTION BILL, REPRESENTATIVE USERS

Case	Option	Educational (channel) Users ($)	CISC Company (Total for 25 CISC's and Master Control Center Facilities) ($)	Private College Network		
				Interconnection ($)	Hook-up ($)	Total ($)
1.	I (Corporate) Turnkey Case	$102,158	—	—	—	—
3.	I (Municipal) Turnkey Case	91,609	—	—	—	—
5.	II (Corporate) Turnkey Case	—	530,706	30,626	49,232	79,858
7.	II (Municipal) Turnkey Case	—	478,613	27,609	49,232	76,841
9.	III (Corporate) Turnkey Case	104,384	—	—	—	—
11.	III (Municipal) Turnkey Case	93,842	—	—	—	—
13.	IV (Corporate) Turnkey Case	146,510	—	18,978	51,166	70,144
15.	IV (Municipal) Turnkey Case	133,126	—	17,255	51,166	68,421
17.	V (Corporate) Turnkey Case	158,550	370,839	18,590	51,166	69,756
19.	V (Municipal) Turnkey Case	144,501	338,052	16,949	51,166	68,115

each of the colleges and the nearest network artery. The interconnection system, rather than the cable network, supplied the link for Option II. For Options IV and V, the distance was measured between each of the colleges and the nearest cable system headend. The link was assumed to be provided by cable systems.

The annual interconnection bills shown on Table 19 below illustrate how the choice of options affects classes of users. Downstream users, such as those who provide televised education, clearly benefit from systems which use only microwave. On the other hand, users who need both upstream and downstream channels clearly benefit from the more advanced systems--particularly one such as Option V, which offers substantial economies of scale.

Yet, it should be noted that downstream users gain nothing from these economics of scale. The education users' bills go up by eight per cent between Option IV and V--a reflection of the burden imposed on them by the more sophisticated switching and the complex cable network required for CISC's.

It is precisely because of these economic realities that commercial interconnection and networking--which will initially concentrate upon downstream uses--is unlikely to provide the kinds of two-way broadband networks described in Options II and V.

THE CISC COMPANY

Since there have been no actual applications of the CISC concept, it is difficult to know what prices would be acceptable in the marketplace. It would appear, however, that prices for both video telephone (and larger audience teleconferencing) and terminal use might be reasonable.

The modified tariff model calculated the prices per hour for terminals and studios, rather than prices for channels. However, prices for a multi-party teleconference can be estimated by multiplying the hourly charge for studios times the number of participant CISC's. Thus, for example, a four-party video teleconference, if the per CISC charge is $20 per hour, would be:

20 x 4 = $80 per hour

The prices of CISC services under the assumed typical circumstances for Option II and V are as shown in Table 20 below. In each case, it is assumed that the CISC's operate under municipal ownership, even though the interconnection network which connects them might not. This does not mean that a CISC company could not operate as a private enterprise; it would be unlikely to do so, however, before there existed a great deal of market experience for CISC services. Here, it is assumed that creation of a CISC company in the Twin Cities area would involve considerable innovation and risk, and would likely be a public venture.

The CISC company's prices are relatively immune to changes in its annual bill for interconnection services. Even though that bill ranges from $338,052 to $530,706, prices rise by only $1 per hour. This is because the interconnection bill is a relatively small part of the CISC company's operating

costs.

TABLE 20. PRICES OF CISC SERVICES PER HOUR

Case #	Option	Video Teleconferencing (Per CISC Per Hour)($)	Terminal (Per Terminal Per Hour)($)
21.	II (Corporate) Turnkey	18	8
22.	II (Municipal) Turnkey	18	8
23.	V ((Corporate) Turnkey	17	7
24.	V (Municipal) Turnkey	17	7

It is possible, however, that estimates of demand for the CISC facilities themselves could be in error. This possibility was explored in two ways. First, a "Slow Growth Case" was established for the CISC company, in which the demand for service grew gradually. For each case (#21-24), the price for video telephone service rose by $8 per hour, and the price for terminals rose by $4 per hour.

Second, it was postulated that the demand estimates might simply be in error. Demand estimates 10 per cent, 20 per cent and 30 per cent above and below the assumed demand level for CISC facilities were examined for their impact on CISC prices. The results are shown in Table 21 below.

TABLE 21. THE IMPACT ON THE PRICES OF CISC SERVICES BY CHANGES IN DEMAND

Type of CISC Service	Percentage Change in De.:and						
	0	+10%	+20%	+30%	-10%	-20%	-30%
Video Teleconference	$18/hr	$17/hr	$15/hr	$14/hr	$20/hr	$23/hr	$26/hr
Terminals	$8/hr	$7/hr	$7/hr	$6/hr	$9/hr	$10 hr	$11/hr

These figures indicate what would be expected--that is, major changes in the number of hours of use of the CISC facilities have a profound effect on the price structure for CISC facilities and, in turn, on the overall economic health of the CISC company. It is clear that the CISC company could be in a serious economic condition even though the CISC cable network company may be in good health financially. In Option II, the fortunes of the interconnection network company are closely linked with those of the CISC company, its main customer. One advantage of Option V is that it does not link the success of the interconnection network company to that of the CISC company.

SUMMARY

It must be remembered that despite the detailed discussion of interconnection prices and users' bills, there has not been an estimate of economic feasibility for any of these systems. The analysis of prices has done no more than yield clues--but important ones--about how several different kinds of interconnection companies and a CISC company might operate under various circumstances. A full-fledged feasibility analysis awaits a more thorough estimate of demand. That is now feasible, with the results of this analysis and several concrete prototypes for further examination.

The analysis of prices yields two additional important insights. First, despite the hypothetical nature of much of the analysis, the interconnection companies set forth have considerable financial resilience. For example, a change in the bond rate from 5.5 per cent to seven per cent raises prices for network services under municipal ownership by only one per cent. Also,

an increase in price of $47 for downstream capacity per channel-mile per year (a 20 per cent increase) will raise the system's return on investment from 15 per cent to 25 per cent, assuming that demand remains the same.

Second, in most instances, the cost of interconnection services appears to be equal to or less than those for existing methods of transmission, especially when a large volume of services is involved, as is proposed here. The economies of scale made possible by these interconnection systems are impressive, as the following illustration demonstrates.

Northwestern Bell was asked to furnish the costs for the long-term lease of a single one-way TV channel from the East Bank Campus of the University of Minnesota (the proposed location of the master control center in Options II, IV and V) to the St. Paul Vocational Trade School (CISC #3) and the Rosemount High School (CISC #22). The charge quoted to the St. Paul Vocational Trade School would be $13,200 to $14,000 (plus or minus 20 per cent) per year plus a one-time installation charge of $2,500. The charge by the interconnection system under Options II and V would range from a low of $1,376 to a high of $2,924, with no installation fee. To Rosemount, the telephone company quoted a charge of $48,000 to $54,000 (plus or minus 20 per cent) with a $12,000 installation fee. The comparable interconnection charge under Options II and V would range from $3,910 to $8,308.[1] While the complexity of the telephone company rate structure prevents any simple

1. Source: Jon Shafer, Telecommunications Planner, Metropolitan Council Staff, and Mr. J. Tremmel, Assistant Marketing Manager, Northwestern Bell Telephone Company.

extrapolations of rates, it is clear that allowing broadband communications users to make their own arrangements individually would be an extremely expensive public interconnection strategy.

Finally, it should be noted that the economic analysis does not make the process of choice less difficult. Whether these systems, the services they offer and the prices they charge add up to an important public value remains to be seen. There are other competing priorities for the attention of public officials and the investment of public funds. The economics of interconnection, as set forth in this discussion, do no more than illuminate subsequent discussions to discover in fact how interconnection services in the Twin Cities area should be valued.

VI. SOME HARD FACTS ABOUT SOFTWARE

The subject of most of this report is "hardware"--coaxial cable, microwave antennas, television cameras and various pieces of electronic equipment. But these facilities and equipment, even when properly designed together into system options as described in Chapter IV, do no more than provide the means of presenting information to viewers and users. The content of the information carried by those systems involves what is known as "software."

In computer technology, software is characterized as computer programs, their documentation and the training required for people to use and maintain the programs. In television, software means live programming, videotapes and films, transmitted off-the-air or delivered by cable systems.

The five interconnection systems defined in Chapter IV deliver or make use of both kinds of software. But it is assumed in the analysis that, with the single exception of the computer programs used to control the systems,[1] the content of the information or the software carried by the interconnection systems is of no concern to either the entity which manages the system or that which regulates the system.

There are several reasons for this. First, this report is intended

1. See Chapter IV, supra at page 62, for a description of the computer-based control aspects of the CISC system.

to examine the costs of communicating or delivering various kinds of information. Adding the costs for producing that information would be superfluous at this time and confuse more fundamental issues. Second, most of the users of the interconnection system will produce their own software. Finally, sound public policy increasingly requires that the process of producing software--especially television programming--be separated from the delivery and exhibition of the programs.[1] This is thought to be an effective way to avoid giving information carriers--which an interconnection system may well be[2]--an economic interest in editing or controlling what is transmitted, and thereby exercising censorship.

However, the software must still be produced; and in both computer and television applications, software is expensive. This chapter briefly steps away from the hard, specific analyses of the previous two chapters into a more speculative area. It is an attempt to provide the Metropolitan Council with an overview of software costs. It is not intended to provide the exact costs of providing software to program fully each system option. Rather, it should serve to familiarize the council generally with the order of magnitude of software costs.

TELEVISION SOFTWARE

The software produced in television broadcasting is extraordinarily expensive. For example, the cost of producing prime time commercial

1. See generally, Report to the President, Cabinet Committee on Cable Television, Office of Telecommunications Policy, January 1974, Washington, D.C.
2. See Chapter VII at p.144 for a discussion of whether the designed interconnection systems would be characterized as common carriers.

network programming averages $120,000 per half-hour.[1] Public television programming costs are considerably lower, as indicated in Table 22 below:

TABLE 22. COSTS OF SELECTED PUBLIC TELEVISION PROGRAMS, 1970-71 SEASON[2]

Program	Producer	Average Cost Per Episode ($)	Average Cost Per Hour ($)
World Press	KQED (San Francisco)	4,500	4,500
The French Chef	WGBH (Boston)	8,750	17,500
San Francisco Mix	KQED	22,250	44,500
Realities	NET (New York)	46,000	46,000
The Advocates	KCET (Los Angeles)	50,000	50,000
Great American Dream Machine	NET	100,000	67,000
Sesame Street	Children's TV Workshop (New York)	50,000	50,000
Book Beat	WTTW (Chicago)	18,000	36,000
Easter at Boy's Town (special)	Nebraska ETV	6,900	13,800
Hollywood Television Theatre (regular)	KCET	36,000	36,000
Hollywood Television Theatre (specials)	KCET	125,000	62,500

1. Roger G. Noll, Merton J. Peck, and John J. McGowan, Economic Aspects of Television Regulation (Washington: The Brookings Institution, 1973) p. 5.
2. Noll, Peck and McGowan, Television Regulation, p. 224.

However, these shows are for the most part networked across the country by the Public Broadcasting System and therefore tend to approximate commercial television production costs. The Broadcast Research Center of Ohio University has surveyed program costs for local shows produced by public television stations as shown in Table 23, which follows.

TABLE 23. AVERAGE COSTS OF LOCALLY PRODUCED PUBLIC BROADCASTING PROGRAMS

Category of Programming	Average Cost/Hour ($)
Simple, in-studio discussion show	1,000
In-school instruction program requiring special set-up, such as a laboratory or shop	3,600
Remote coverage of an event such as a city council hearing or basketball game	3,700
Documentary	12,000

Programming costs for local origination programming by cable system operators ranges from $60 to $1,000 per hour, with $250 per hour being a good estimate of the average.[1] Televised educational programming costs, however, are more likely to range between $3,500 and $4,500 per hour.[2]

In order to illustrate the estimated annual costs of programming the 15 channel educational package discussed in Chapter III, the center assumed that each channel would carry 20 hours of programming per week. (It was further assumed that those 20 hours of programming were shown three times

1. Source: Brian Owens, Cablecasting Coordinator, National Cable Television Association, Washington, D.C., June, 1974.
2. Richard Adler and Walter S. Baer, Aspen Notebook: Cable and Continuing Education, (New York: Praeger Press, 1973) p. 112.

each week for a total of sixty hours of "air-time" per channel per week). Further, the annual costs of programming this channel package was computed for three different levels of origination: cable system origination ($250 per hour), televised educational programming ($3,500 per hour) and network public television programming (averaged roughly at $30,000 per hour). The results are portrayed in the following table.

TABLE 24. ESTIMATED PROGRAMMING COSTS FOR TWIN CITIES (15-CHANNEL PACKAGE)

Type of Origination	Cost Per Hour ($)	Weekly Cost of 20 Hours of Programming on 15 Channels ($)	Annual[1] Cost of 20 Hours of Programming on 15 Channels Weekly ($)
Cable television origination	250	75,000	3,750,000
Televised educational programming	3,500	1,050,000	52,500,000
Network public television programming	30,000	9,000,000	450,000,000

Using the figures in Table 24 above as the annual costs for different levels of programming for the 15-channel package, some additional assumptions must be made in order to determine how many viewers would be needed in the metropolitan area to support--that is, pay for--the package. These assumptions are:

1) That nonprogramming costs (costs of equipment, rental of facilities, etc.) equal programming costs;[2]

1. Based upon 50 weeks per year.
2. Noll, Peck and McGowan, Television Regulation, table p. 90.

2) That tuition charges are to average $1.50 per program hour per student;[1] and

3) That there is a charge, equaling 20 per cent of the total investment, which represents the costs involved in raising the amount of funding needed for the programming and nonprogramming charges yearly.

Having made those assumptions, and using a formula explained in detail in the Appendix, the center computed the average audience for the entire 15-channel package needed at any one time to support the package. These results are noted in Table 25 below.

TABLE 25. AVERAGE NUMBER OF VIEWERS NEEDED TO PAY FOR 15-CHANNEL PROGRAM PACKAGE

Type of Origination	Annual Cost of 20 Hours of Weekly Programming on 15 Channels ($)	Number of Viewers of All Channels At Any One Time[2]
Cable television origination	3,750,000	2,000
Televised educational programming	52,500,000	28,000
Network public television programming	450,000,000	240,000

These "average viewers" figures give the Metro Council some sense of the size of audience needed to pay for the 15-channel package. Clearly, it would be impossible to support the package if the annual production costs

1. Adler and Baer, Aspen Notebook: Cable and Continuing Education, p. 121.
2. This number represents the average number of viewers of all 15 channels at any given time, assuming programs are shown three times each and that one-third of the total audience watches each time.

approached those of network public television, since 240,000 average viewers represents nearly one-fourth of all the television homes in the metropolitan area. However costs of $3,500 per hour or less and 28,000 viewers--approximately 2.9 per cent of the more than one million television households in the Twin Cities television market--appear to be obtainable goals.

The Aspen Institute published recently in its Notebook series a report on cable television and continuing education. In that report there are two interesting and pertinent discussions about educational television. The first describes a project developed by the Southern California Regional Consortium for Community College Television. Parts of this discussion are reproduced here to demonstrate the financial feasibility of educational television which is innovatively deployed.[1]

> In 1967 the Los Angeles ABC-affiliate station KABC-TV asked Pasadena City College to develop a college-level course to be broadcast over the station. It offered free use of production facilities and free broadcast time during low-demand early morning hours. The college responded affirmatively, and the result was a three-unit course in art history, consisting of broadcast lessons, supporting readings, telephone consultation between students and faculty, voluntary on-campus seminars, and required on-campus examinations. Nearly 1,800 students enrolled for credit the first semester.
>
> Pasadena's success encouraged other community colleges in the region to join in a formal television consortium that now includes 26 institutions. It is guided by both a professional director (housed on the "neutral ground" of the Los Angeles County school system office) and a number of inter-institutional committees with responsibilities for (1) organization and legislation; (2) curriculum, innovation, instruction and evaluation; (3) promotion and

1. Adler and Baer, Aspen Notebook: Cable and Continuing Education, pp. 111-114.

publicity; and (4) production. By the end of the 1972-73 academic year, the consortium will have produced and offered the nine courses listed below, attracting enrollments now averaging over 5,000 students each term.

Each consortium member contributes $3,000 yearly, and this $78,000 budget covers general expenses plus the production of the one or two courses each year. All production to date has utilized the free facilities and personnel of commercial television stations; thus, the consortium now pays only for faculty time, graphics, tape and other materials, and similar non-studio costs. These costs for a three-unit course average about $20,000. In addition, the costs borne by the producing stations are estimated by the consortium director as ranging between $50,000 and $100,000 for the 45 half-hours of television included in each course. Thus the production cost per hour is in the $3,000 to $5,000 range. The non-television

Term	Course	Enrollment
Fall 1970	Effective Living (health education) Psychology I	380 309 689
Spring 1971	Law for the 70's (consumer law) Psychology I	404 427 832
Summer 1971	History of World Theatre	1,744
Fall 1971	Effective Living History of Mexico	2,754 5,277 8,031
Spring 1972	History of Art IA Law of the 70's	3,549 3,407 6,956
Fall 1972	Introduction to Astronomy History of Art IA	2,312 3,416 5,728
Spring 1973	Physical Geography Consumer Education	-- --

incremental costs (primarily faculty salaries) for the consortium members are estimated at about $500 per campus for each course. Each campus can recover up to one-half of the consortium contribution and incremental costs from state funds; the rest comes from their general operating budgets.

Courses to be produced and offered are selected by an inter-institutional committee, which also selects the producing instructors after reviewing competing proposals. To date, courses have dealt with topics of broad interest primarily outside the list of courses required for the AA degree. This determination was made with an eye to appealing to a large audience while avoiding the threat to faculties that might be represented by broadcasting basic required courses.

. . . .

Course programs are broadcast over a commercial station during low-audience early morning hours and over the local public broadcast station in the evening. Student participation consists of viewing the 45 half-hour broadcasts (for a three unit course), completing reading assignments, and taking a mid-term and final examination on the campus he has elected. Each student has the privilege of attending voluntary seminars, and of consulting via telephone or in person with an instructor at the campus of registry during designated hours.

The consortium is considered a success by the participating institutions. In the words of a consortium handout: "Firemen, whose schedules often prohibit campus classes, can take televised courses. Mothers whose home responsibilities prevent their coming to campus are able to attend classes via television. And regular students whose campus class sections are closed are able to find room within the elastic walls of a televised course." In short, the program serves previously by-passed populations and regular students as well. Another consortium statement claims that these courses are not substitutional but, in fact, attract new students into the system: "Several semesters of experience have led us to the conclusion that there is no discernible decrease in

> on-campus enrollments when a course is televised. On the contrary, televised community college courses attract new students, who become acquainted with their community college through television." However ...there are recent indications that some new courses are leading to cancellation of on-campus course sections.
>
> . . . .
>
> Consortium courses are available to other institutions at a charge of $75 per half-hour segment for unlimited use during a semester. However, little active marketing has been undertaken. To date, only one course (art history) has been exported for use in the San Francisco area, where it was broadcast over a commercial station to an early morning audience of 225 enrolled students.

Another discussion from the same source, illustrates another televised education project.[1]

> The Northern California ITV Consortium was established in the fall of 1972 "to extend the effective service area of colleges and universities in Northern California...[in order to] serve the continuing education needs of all adults in the region." Part of the consortium's purpose is to enlarge the curricula of participating schools, but its primary aim is to extend educational services to persons not now reached by these institutions. The consortium, which is based at California State University at Sonoma, received a total of $70,000 for its first year from state funds and from the Title I program of the federal Higher Education Act.
>
> Under the direction of Dr. Stuart Cooney, the structure of this consortium is much less formalized than that of the Southern California Regional Consortium. There are no set guidelines for participation, and the courses it offers are intended to be experimental and innovative. Ultimately, the consortium hopes to include the six state universities, the two University of California campuses and the 34 community colleges in the region, but at present, the state universities are the most active participants. However, three community colleges have representatives on the consortium steering committee and faculty members from the University of California at Davis are participating as individuals in the planning of a new course. Dr. Cooney is satisfied

1. Adler and Baer, Aspen Notebook: Cable and Continuing Education, pp. 115-117.

with this arrangement, since he believes that keeping the consortium structure as open as possible is the best way for it to grow.

The consortium's first course, "Health, Poverty and Public Policy," was offered via television in the spring of 1973. The purpose of the course is to inform and sensitize public officials to the health needs of the poor. The syllabus covers available health resources, assesses their quality, and explores the problems of the poor in gaining access to them.

The target audience for the course was a wide range of state and local government officials, as well as private individuals involved in health-care and poverty programs (the head administrator of a group medical practice is one example). The course was taught by Dr. George D. Kent of the Department of Political Science at Chico State University. Dr. Kent had previously taught a classroom version of the course at Yuba College in Marysville as part of Chico State's extension service at three educationally isolated locations in Northern California--Marysville, Susanville, and Redding--and television seemed an attractive alternative for reaching a widely scattered audience. But Dr. Kent had had no previous experience with teaching by television, and he quickly learned that planning and preparation for the course required considerable amounts of his time and creative energies.

"Health, Poverty and Public Policy" was presented as a two-credit course on five Saturday mornings in Spring 1973. The course programs originated from Redding and were carried live over the educational television stations (linked by microwave) in Chico, Redding and Humboldt. The course was intended to be watched in groups and was structured to maximize active individual participation, both through local group discussions and through call-in questions. The three primary viewing sites at Marysville, Susanville, and Redding had paid moderators. In addition, other viewing sites were established wherever three or more enrolled students could be gathered. In these circumstances, one participant served as group leader. Considerable effort was put into the course promotion in order to reach the economic break-even point of 480 studen

The course budget was as follows:

Expenses	
Instructional salaries (faculty, guests)	$ 2,700
Production expenses	3,000
Transmission costs 15 hours @ $125/hr.	1,875
Support personnel	1,000
Other support costs (travel)	565
Evaluation	1,760
Planning, development, promotion	9,000
	$19,900

Revenues	
Federal funds	$ 5,000
Direct consortium contribution	1,500
Student fees 480 @ $28	13,440
	$19,940

These two case histories indicate that televised education, including perhaps interactive television via CISC's, as is proposed in Options II and V, can be economically feasible, even though the aggregate costs are high. In the Twin Cities area, the costs of interconnection will be greatly exceeded by the programming costs for televised education, but the prospect that the programming might pay for itself is encouraging.

COMPUTER SOFTWARE

As used here, computer software is intended to mean computer programs and services offered through the CISC portion of the interconnection system. As noted in Chapter IV, there is also software involved in controlling the use of the various express counters and interactive television terminals, and in accounting for the channel allocations among the CISC's. MITRE Corporation estimated this software to cost $300,000.[1]

The cost of computing power for instructional use is not well-defined at this time. MITRE estimated that software development for courses to be presented over its experimental TICCIT system would range from $200,000 to $1,200,000.[2]

Other computer costs are not dependent upon the software costs. The following table indicates typical packaged computer applications and their monthly costs.

It should be noted that for the high capacity general purpose machine (#5), total annual operating costs can easily exceed $1 million. However, this figure is considerably less than software costs for television. Moreover, reductions in the cost of computer communications will mean a significant reduction in overall computer service costs, since communications are a more significant cost component than in television services.

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1. MITRE, Interactive Television, p. 142.
2. Ibid., p. 143.

TABLE 26. TYPICAL COMPUTER COSTS[1]

Type System	Core Store Size (bytes)	Magnetic Tapes		Printer Speed (lines/min)	Card Reader Speed (cards/min)	Monthly Rental ($)			Cost/Min[2] ($)
		No.	Speed (characters/second)			Low	Average	High	
1. Card system	5,000	0	0	1,000	1,000	1,085	3,704	6,130	0.77
2. Business	10,000	6	30,000	500	500	3,680	9,754	26,003	2.03
3. Random access	110,000	4	120,000	1,000	1,000	19,470	38,227	85,107	7.96
4. Business/scientific	40,000	6	30,000	500	500	9,379	19,462	49,180	4.05
5. General purpose	120,000	20	120,000	1,000	1,000	38,720	49,671	57,600	10.34

1. Stanley Rothman and Charles Mosmann, <u>Computers and Society</u> (Chicago: Science Research Associates, Inc. 1972) p. 78.
2. One shift rental, 160 hours/month. Cost of actual operation roughly doubles the machine costs to account for supplies, space, personnel, power, air-conditioning, and so forth.

SUMMARY

The various costs noted here for both television and computer software are not firm and invariable. Rather they are subject to a number of variables, many of which--at least in the case of television software--can be controlled and shared by users and producers. Although, the relation between a governmental unit such as the Metropolitan Council and the production and development of software must be--for sound public policy, First Amendment and other reasons--an "arm's length" one, there is definitely a role for public officials in encouraging and assisting this development.

VII. LEGAL AND REGULATORY FACTORS AFFECTING INTERCONNECTION IN THE TWIN CITIES AREA

The purpose of this chapter is to apprise the Metropolitan Council of some of the federal and state statutory and regulatory provisions which may be applied to the interconnection systems suggested in Chapter IV. The following survey is not intended to be exhaustive. For example, there is no discussion of the possible applicability of federal or state antitrust statutes to a communications system wherein both the programming and distribution facilities are owned by the same entity. While this could eventually be at issue, it is not among the more readily foreseeable problems.[1] Nor is it reasonable to expect that some of these problems will be solved without litigation or legislation. Rather, the various issues are noted and dicussed to alert the council to the types and dimensions of the questions to be raised. How and when the council should approach the resolution of these questions will be discussed in Chapter VIII.

FEDERAL LAWS AND REGULATIONS

ASSERTION OF FEDERAL JURISDICTION

The council should be aware of the possibility that the Federal Communications Commission might--under existing regulations--assert jurisdiction over the interconnection system on the theory that the interconnection system

1. It should be noted in this regard that the cabinet-level committee on cable television recommended that "[c]ontrol of cable distribution facilities should be separated from control of programming and other services provided over the channels on those distribution facilities." Report to the President, Cabinet Committee on Cable Communications, January 1974, Washington, D.C., p. III-1.

is a common carrier and/or, itself, a cable television system. The proposed options would be unique communications systems--entities not heretofor encountered by the commission. However, all of the systems would be composed of familiar elements.

The FCC defines a cable television system as:

> [a]ny facility that, in whole or in part, receives directly, or indirectly over the air, and amplifies or otherwise modifies the signals transmitting programs broadcast by one or more television or radio stations and distributes such signals by wire or cable to subscribing members of the public who pay for such service, but such term shall not include (1) any such facility that serves fewer than 50 subscribers, or (2) any such facility that serves only the residents of one or more apartment dwellings under common ownership, control, or management, and commercial establishments located on the premises of such an apartment house. [1]

There appears then to be only a slight possibility that any of the proposed interconnection systems could be characterized as a cable television system.

As noted in Chapter IV, Options III, IV and V will deliver distant broadcast signals to area cable systems. These systems potentially could serve all cable systems willing to pay for these broadcast services. No entities or institutions other than cable systems, however, will receive broadcast services directly from the interconnection system. Under these circumstances, it appears that these three proposed interconnection systems could fall under the FCC's definition of cable television system(s) only if the cable operators to whom broadcast signals will be distributed can be described as "subscribing members of the public" <u>and</u> if there are 50 or more such subscribers. While cable systems are not normally viewed as members of the public, it is possible that their relationship to this new entity could be so described, thereby subjecting the

1. 47 CFR 76.5 (a) (1972).

interconnection system to the commission's cable television rules. It is highly unlikely, however, that there would be more than 50 such "subscribers" or cable systems in the seven-county council area. Thus, it is doubtful that any such interconnection system would be classified as a cable television system and subject to the federal rules. Moreover, should an interconnection system be so characterized, it would be possible to seek waivers of the regulations.

More likely, however, is the assertion of jurisdiction over the system as a common carrier. The FCC can assert jurisdiction over "...any person engaged as a common carrier for hire, in interstate or foreign communication by wire or radio or in interstate or foreign radio transmission of energy..."[1] The commission has determined that a carrier otherwise engaged in only intrastate communications, but which carries television broadcast signals for hire, is engaged in interstate communications and is thus subject to federal regulation.[2] Therefore, it would seem that the proposed interconnection systems would qualify as an interstate common carrier. It should be noted, however, that "person" is defined as including "an individual, partnership, association, joint-stock company, trust, or corporation."[3] It is not yet settled as to whether a public entity is considered a "person" within the meaning of this Act, and thereby subject to common carrier regulation. The FCC's opinion of the question should be solicited if the interconnection system is to be controlled by a public entity.

On the assumption that this system will be regulated as a common

1. Communications Act of 1934, 47 USC 153(h)(1934).
2. General Telephone Company, 13 FCC 2d 448 (1968) aff'd General Telephone Company v. FCC, 413 F. 2d 390 (D.C. Cir.), cert. denied 396 US 888 (1969).
3. Communications Act of 1934, 47 USC 153 (i)(1934).

carrier, the council should know that carriers are required, among other things, to furnish communication service upon reasonable request therefor; to establish physical connections with other carriers as ordered by the commission; to file tariffs establishing rates, terms and conditions regarding its services; to conform to a uniform system of accounts prescribed by the FCC; and to seek commission certification before commencing operations.[1]

CABLE TELEVISION RELAY SERVICE--LOCAL DISTRIBUTION SERVICE[2]

Cable television relay (CAR) service is a form of microwave service which is used to deliver television and radio signals from a single transmitter to one or more headends. Its use is authorized by the FCC especially in areas where geographic barriers or the high cost of underground construction make cable interconnection prohibitively expensive. A CAR station may be fixed or mobile. The term itself is defined to include "local distribution service stations," more commonly called LDS stations.[3]

The rules regulating CAR stations provide, in part, that they are "authorized to relay television broadcast and related audio signals, the signals of standard and FM broadcast stations, signals of instructional television fixed stations, and cablecasting intended for use solely by one or more cable television systems."[4] A CAR station must be operated principally to retransmit television broadcast material or cablecast programming. However, this requirement does not apply to LDS stations. LDS stations may relay, in addition to all of the above, other types of communications as authorized by the commission.

1. See generally, Communications Act of 1934, Subchapter II--Common Carriers.
2. See generally, 47 CFR Section 78, Subpart B (1972).
3. Ibid. at 78.5(b).
4. Ibid. at 78.11(a).

> CAR licensees may interconnect their facilities with those of other CAR or common carrier licensees, and may also retransmit the signals of such CAR or common carrier stations, provided that the program material retransmitted meets the requirements of this paragraph.[1]

Programming transmitted or relayed by the CAR station can only be delivered to a cable system if the receiving system's owner or operator is also the holder of the CAR license, or where the service is supplied either without charge or on a nonprofit, cost-sharing basis (i. e., as in a cooperative of cable owners.) Where the service is provided on a cost-sharing basis, the FCC requires a written contract between the parties involved providing that the CAR service licensee have:

> ... exclusive control over the operation of the cable television relay stations licensed to him and that contributions to capital and operating expenses are accepted only on a cost-sharing, non-profit basis, prorated on an equitable basis among all cable television systems being supplied with program material in whole or in part.[2]

The licensee must maintain records showing the cost of the service.

Each CAR licensee providing program material on a nonprofit, cost-sharing basis must file an annual report with the commission within 90 days of the close of its fiscal year. The FCC also requires these licensees to file a notification at least 30 days prior to supplying program material to any cable television system that has not been specified in its license application. The commission must be kept apprised of the nature and cost of all programming supplied to cable television systems by the licensee.

Another regulation, which may be of special interest to the council,

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1. Ibid.
2. Ibid. at (c)(2)

should it choose to implement Option III utilizing LDS under some form of public ownership, provides that only an owner or operator of a cable system or a cooperative of cable system owners is eligible to apply for a CAR license.[1] Enforcement of this provision would prevent public ownership of any interconnection entity using LDS. However, the commission has to date granted two waivers of this rule.[2]

At the present time, no CAR LDS licenses have been granted or applied for in the Twin Cities area. Usually, only one CAR-LDS license is granted in an area the size of the Twin Cities. As a result, the council should be aware that its implementation of any public interconnection system using LDS will be limited by these rules and will necessitate seeking an FCC waiver.

MULTIPOINT DISTRIBUTION SERVICE[3]

Although none of the systems proposed in Chapter IV ... izes Multipoint Distribution Service (MDS), the council should be aware of its existence, capabilities and legal status in the Twin Cities area. A Multipoint Distribution Service system basically consists of a fixed station transmitting omnidirectionally to numerous fixed receivers in an area. Twelve megahertz or two full television

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1. Ibid. at 78. 13.
2. Most recently, the commission allowed a cable television operator to assign its CAR licenses to a broadcaster in Re Application of Waiver--TVC Corp. 45 FCC 2d 408 (1974). The FCC also waived this rule to allow Hampshire College to own and operate a cable television relay station at Amherst, Massachusetts, in The Trustees of Hampshire College, 40 FCC 2d 627 (1973). The college, in its petition to the commission, stated that a CAR station was necessary to enable it to provide educational and cultural programming for the educational access channel of the local cable television system. The FCC granted the waiver, stating that the public interest in the economical distribution of the programming and the lack of a reasonable alternative suggested that the waiver would be appropriate. In addition, the commission stated that this issue may well deserve further examination, perhaps in a rulemaking proceeding.
3. See generally, 47 CFR Section 21 (1974).

channels per a specific geographical area are assigned for this service. This low channel capacity somewhat restrains MDS usage for local interconnection.

Moreover, there are some significant restrictions upon the operation of MDS service, including the following:

> (1) the carrier is not substantially involved in the production of the writing of, or the influencing of the content of any information to be transmitted over the facilities;
>
> (2) the carrier does not render service to any entity who is affiliated with or related to the carrier whenever the total hours of service rendered to related subscribers exceeds the total hours of service rendered to unrelated subscribers within any calendar month;
>
> (3) the carrier controls the operation of all receiving facilities. . . ; and
>
> (4) the carrier's tariff allows the subscriber the option of owning the receiving equipment. . . [1]

Communications common carriers are the only entities eligible for MDS licenses. The applicant must show that it is qualified to provide the proposed service and that the public interest would be served by such service.

In 1972, Microband Corporation of America was granted a license for one of the two available channels of MDS in the Twin Cities market. There are currently four applicants vying for the license for the second channel.

INSTRUCTIONAL TELEVISION FIXED SERVICE[2]

Instructional Television Fixed Service (ITFS) is a low-cost service designed principally to interconnect schools and colleges. It can be used for other public services which have some educational functions.

The ITFS system itself is "[a] fixed station operated by an educational

1. Ibid. at 21.903.
2. See generally, 47 CFR Section 74, Subpart I.

organization and used primarily for the transmission of visual and aural instructional, cultural, and other types of educational material to one or more fixed receiving locations."[1] ITFS stations may be licensed to transmit "...instructional and cultural material in visual form with an associated aural channel to specified receiving locations for the primary purpose of providing a formal education and cultural development to students enrolled in accredited public and private schools, colleges, and universities;"[2] educational programming for in-service training and instruction in special skills and safety programs; data and statistics and other material related to the licensee's administrative activities when the circuits are not carrying educational or cultural programming; and "for operation as relay stations to interconnect instructional television fixed station systems in adjacent areas.."[3] Licensees may be assigned up to four channels in any one area.[4] More than one licensee may be assigned the same channel in an area provided such assignment causes no interference.[5]

Finally, and of particular interest to the council, the commission's ITFS rules further provide that only:

> ...an institutional or governmental organization engaged in the formal education of enrolled students or...a non-profit organization formed for the purpose of providing instructional television material to such institutional or governmental organizations...

is eligible to apply for an instructional television fixed station.[6] This requirement would force the operator of a privately owned interconnection entity

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1. 47 CFR 74.901 (1972).
2. 47 CFR 74.931 (a)(b)(c) and (d)(1972).
3. Ibid.
4. 47 CFR 74.902 (c)(1972).
5. Ibid. at (d).
6. Ibid. at (a).

employing an ITFS station to seek a waiver of this rule.

Seven bands (labeled A through G), each with four channels of television allocated to it, are available for licensing in a specific geographical area. In the Twin Cities area, there are a number of ITFS stations already licensed. The Independent School District 279 in Osseo has held the license for one channel since 1966. In 1971, the FCC granted licenses to the regents of the University of Minnesota for four channels of ITFS, and a license to operate one channel has been assigned to the Twin Cities Area Educational Television Corporation in Falcon Heights.

COMMUNICATIONS SATELLITE FACILITIES

Although any satellite network would not be, strictly speaking, a component of a local interconnection system, the status of regulation affecting satellite earth stations is discussed here because of their inclusion in Options IV and V.

The FCC released its Second Report and Order on satellite policy in June 1972.[1] The commission's policies with regard to earth station ownership, access to and interconnection of earth stations and the terms of access by educational interests are flexible and, at least initially, quite favorable to the development of public services on a regional basis. First, the FCC stated that it was "in favor of according special purpose users (such as commercial and non-commercial local broadcasters, other educational users, cable systems, or local carriers) the option of owning receiver-only earth stations."[2] A public authority of some kind--although perhaps not strictly an "educational user"--

1. In the Matter of Establishment of Domestic Communication Satellite Facilities by Non-Governmental Entities, 35 FCC 2d 844, 845 (1972).
2. Ibid. at 757.

would probably fall within this policy.

Second, the commission approved the policy recommendations of its staff with regard to access to authorized earth stations. The policy is that "...any common carrier earth station licensee shall permit non-discriminatory and equitable access to such earth station facilities by means of terrestrial interconnection facilities authorized by the Commission to other carriers and users."[1] Simply put, the FCC will pursue a policy whereby all users may have access to satellite earth receiving stations owned by common carriers such as the telephone or telegraph companies. Moreover, with respect to interconnection, the commission stated that it expected terrestrial common carriers seeking domestic satellite authorizations to present to the FCC their plans for interconnecting with satellite systems and earth stations.[2] Finally, the commission recognized the "well-established national policy... which encourages and makes it lawful for common carriers to provide free or reduced rate interconnection services to public broadcasting and other educational interests."[3] The national policy mentioned above included that of the Higher Education Act of 1968 and may thus be particularly applicable to colleges and universities.

In conclusion, the FCC's policies on satellite technology seem to offer no insurmountable obstacles to the use of satellite receiver stations in either a publicly or privately owned interconnection entity.

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1. In the Matter of Establishment of Domestic Satellites Communications, 34 FCC 2d 1, 65 (1972) (Staff Recommendations).
2. In the Matter of Establishment of Domestic Communications--Satellite Facilities by Non-Governmental Entities, 35 FCC 2d 844, 845 (1972).
3. Ibid. at 859.

STATE AND LOCAL LAWS AND REGULATIONS

In addition to the many ways in which the development of the proposed interconnection system might trigger the imposition of federal regulation, there are a number of Minnesota state statutes and regulations and municipal ordinance provisions which may be applicable to any of the interconnection systems designed in Section IV.

THE MINNESOTA CABLE COMMUNICATIONS ACT

In creating the Minnesota Cable Communications Commission, the State Legislature in 1973 explicitly granted that Cable Commission jurisdiction over cable system interconnection. Among its other duties, the Cable Commission has been directed to "prescribe standards for...the interconnection of all cable systems within this area [the Twin Cities Metropolitan Area][1]...which designate a uniform regional channel reserved for public use,..."[2] and "...prescribe standards for interconnection and compatibility of cable communications systems."[3] These provisions place broad powers of regulatory jurisdiction over any interconnection system in the Cable Commission's hands.

Additionally, as was mentioned in Chapter I of this report, the Metro Council has authority to study cable system interconnection by virtue of the 1973 act.[4]

THE METROPOLITAN COUNCIL ACT

Recent amendments to the Metropolitan Council Act may well be construed to grant the council authority over any interconnection system. Under these

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1. Minnesota Annotated Statutes, Chapter 568, (1973).
2. Ibid.
3. Ibid.
4. Ibid.

provisions, it is required to review "all proposed matters of metropolitan significance to be undertaken by any private organization, independent commission... local governmental unit or any state agency.[1] Review authority over a regional communications interconnection network or over any fundamental part of such a network would be inherent in these provisions, if the council deemed such networks to be of "metropolitan significance."

OTHER MINNESOTA PUBLIC UTILITIES--RELATED STATUTES AND DECISIONS

Under state statute,[2] the Public Service Commission has jurisdiction over most common carrier services, including telephone and telegraph. There is some question as to whether any proposed interconnection system would fall within the regulatory domain of this department. The Public Service Commission originally had the jurisdiction over transportation and shipping carriers such as railroad, express and trucking companies.[3] More recently that jurisdiction was expanded to include telephone companies.[4]

In a 1965 opinion, the Minnesota attorney general held that a cable television company using wires to distribute its television signal would not be subject to the Public Service Commission's jurisdiction since cable television systems "operate under different methods of transmission than telephone companies, and perform different services."[5]

Additionally, the State Supreme Court, when citing this opinion, has held that a company providing educational television signals via closed circuit

1. Minnesota Annotated Statutes, Chapter 473B, (1974).
2. Ibid., Chapter 237, (1973).
3. Ibid.
4. Ibid.
5. Opinion of the Attorney General, No. 340-1, (1965).

microwave facilities did not fall under the Public Service Commission's authority as either a "telephone company" or as a supplier of "telephone services."[1] This court decision clearly has some applicability to an interconnection facility which relies upon microwave transmission of signals such as that outlined in this report. It should be noted, however, that the court relied heavily on the absence of two-way service in the microwave system in its holding that such service was not "telephone service." Therefore, if the Public Service Commission attempts to assert jurisdiction, it is possible that courts could construe any of the proposed interconnection systems as telephone services within the meaning of the state statute since extensive two-way service is provided.

Finally, the statute on public highway maintenance has some applicability to the interconnection system. "Community antenna television lines. . . may be constructed, placed or maintained across or along any trunk highway," according to a 1973 amendment to that highway legislation.[2] The Commissioner of Highways has promulgated rules and regulations governing the use of state highways for such purposes.[3] These are provisions which should be carefully noted when the time to build any interconnection system comes.

MUNICIPAL ORDINANCE PROVISIONS

One aspect of municipal law which may have a great impact on the construction and design of any interconnection system is that dealing with the aerial or underground placement of utilities. These requirements vary considerably from place to place. Frequently, adjacent municipalities have completely inconsistent provisions, with one community requiring the burial of all wire and cable and the neighboring city having no specific statute.

1. Minnesota Microwave Inc. v. Public Service Commission, 190 NW 2d 661 (1971).
2. Minnesota Annotated Statutes, Chapter 167 (1973).
3. State Highway Department Order, No. 31424.

Finally, a few municipalities in the Twin Cities area have franchised cable television systems. These franchise agreements should be examined to learn what, if any, requirements for interconnection are included therein. If there are interconnection provisions, they should be evaluated to determine if they would have any impact on any planned interconnection system.

SUMMARY

There is a strong possibility that system Options III, IV and V--since they will carry broadcast television signals--would be classified as common carriers by the FCC. As noted above, this assumes private ownership; if there was some form of public ownership of any of these systems, the question of whether a public entity was a "person" within the meaning of the Communications Act of 1934, and therefore subject to FCC regulation, should be raised with the commission. Since system Options I and II will not carry broadcast television signals it is possible that they would not be subject to federal common carrier regulation under any ownership scheme. It should be noted that even though a particular system option might not be deemed a federal common carrier, the use of LDS or ITFS requires FCC licensing.

At the state level, the Minnesota Commission on Cable Communications has explicit regulatory authority over cable interconnection. Finally, the Metro Council, should it choose to characterize the development of interconnection systems as an issue of "metropolitan significance," shall have the power to review plans for interconnection systems.

Chapter VIII discusses the context within which all the issues above should be examined.

VIII. PROCEDURAL RECOMMENDATIONS

> By stimulating open discussion of the consequences of specific technological changes before the impacts are felt by society, the possibility is increased that public and private policy decisions will guide the technological development and, where necessary, regulate the use in a way that maximizes societal benefit. Thereby, limited resources may be allocated to those technological and social changes which best suit society.[1]

As the foregoing chapters demonstrate, the Metropolitan Council has a number of different alternatives available to it with regard to interconnection systems. This study has discussed engineering options, service pricing possibilities and financing alternatives. The purpose of this chapter is twofold:

1) To comment generally on regulatory aspects of any interconnection system; and

2) To provide the Metro Council with a procedure for making decisions with regard to those alternatives.

Before presenting that material, some commentary on the importance of the process the Metro Council faces is appropriate. The quotation above suggests that there is a direct relationship between the evaluative and planning processes which decision makers undertake on the one hand, and the quality of the decisions about technology which they make on the other.

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1. Edward M. Dickson in association with Raymond Barnes, The Video Telephone, A New Era in Telecommunications - A Preliminary Technological Assessment, (Ithaca, N.Y.: Cornell University, June 1973), p. 2.

This concept of technological assessment--that is, the process of anticipating the broad consequences of technological change and planning accordingly--is, in other words, a matter of shaping technology to meet human needs at the early stages of that technology's development. In broadband communications, as in other technologies, there is a question of "lost opportunities": If no action is taken, there are no negative results, only a passing of another chance to mold a resource--that would otherwise go unharnessed--to defined societal needs.

The Metropolitan Council, committed generally to regional planning and specifically here to the exploration of cable communications interconnection, is in a unique position to take the steps necessary to develop cable communications on a regional basis in a fashion that satisfies expressed public communications needs. The following sections were written to assist in that function.

REGULATION OF INTERCONNECTION SYSTEMS

As has been mentioned throughout this study, cable communications interconnection is a new concept which has previously been discussed only in general terms. Hopefully, this report gives more specificity to the concept in a number of areas, especially with regard to the possible designs of local interconnection systems and prices for services offered by those systems. Comparable attention should be given to how an operating interconnection system ought to be regulated.

In the first place, there exist legislation and regulatory rules at both

federal and state levels which will affect interconnection systems. As discussed in Chapter VII, the Federal Communications Commission licenses a number of technological components, one or more of which will be used in any interconnection system. On a more general basis, the FCC could well regulate the entire interconnection system as a common carrier. Moreover, the Minnesota Commission on Cable Communications has explicit regulatory authority over the interconnection of cable systems in the state. Finally, the Metro Council has the jurisdiction to review any local governmental or state agency plan or program which is of "metropolitan significance." As noted in Chapter VII, this legislative grant could confer upon the council considerable regulatory authority over any interconnection system.

It should be mentioned, however, that procedures for actually establishing interconnection systems have not been considered by federal or state authorities. Thus, the council has no regulatory models to which it can turn at this time.

Secondly, it is clear that either the interconnection of cable television systems or the provision of communications services to a region comprised of many political jurisdictions requires broader regulatory supervision than is available at the municipal level. There must be a body which is responsible for both supervision of the day-to-day questions that affect interconnection, as well as the consideration of policy questions and long-range planning. The reasons for including both these functions will be made clear in the second section of this chapter.

Finally, it is possible to make some comments on both the level and type of regulations that will be needed, focusing upon the two different ownership forms, private and public. If it is decided that ownership of the interconnection entity is to be private, the regulations which govern it must be thorough, well-planned and aggressively implemented. This will be especially significant in the early stages of the interconnection system development, where it will be difficult to plan for all of the very real contingencies. For example, should system Option IV be implemented under private ownership, there would be a need for a significant amount of public planning and supervision. This is because in the implementation of that option (wherein coaxial cable is used to link cable system headends), planning could fail to take into account where all the metropolitan areas' cable systems may be built in the future. Such a failure would make it impossible to exchange public programming among all cable subscribers, and would be difficult to remedy inexpensively once the interconnecting cable is in place.

Public ownership raises different, but equally significant regulatory problems. The greatest difficulty, of course, is the very fact that the owner is also the regulator. This can be remedied in part by making the regulator a newly created, independent regulatory body or by assigning the function to an existing governmental body other than the one which owns the interconnection system. Moreover, governmental ownership of a potentially important communications medium--even though one which may well be operated as a common carrier--raises issues of constitutional freedoms.

Actions to discriminate among those who seek to use the interconnection system for the delivery of programming is a foreboding prospect, no matter who controls the system. But its implications are even more serious if government is the owner. In any event, regulation of publicly owned communications facilities, such as those designed in this report, must focus considerable attention upon these issues.

Appropriate regulation for cable television systems is difficult to formulate when there are unanswered questions about system design, ownership and financing, and management. It becomes even more difficult when considering interconnection system regulation. Yet with an explicit understanding of what the Metro Council's regulatory goals are, it will become easier to enact reasonable rules.

SUGGESTED DECISION MAKING AND PLANNING PROCEDURES

There are two levels of decision making and planning in which the Metropolitan Council should operate in the implementation of this report. The first is a long-range planning and decision making process to be undertaken by the council and its committees. The second level concerns more day-to-day matters and concentrates upon actions which the council might need to take during the long-range planning process to ensure that its choices remain open.

THE LONG-RANGE PLANNING AND DECISION MAKING PROCESS

The long-range planning process may, but need not necessarily, take as long as two years to complete. However, the council should place an outside limit on the amount of time it will spend on this task.

The four essential substantive aspects of this plan should be as follows:

1) An informational and educational program for potential users of any interconnection system and the general public;

2) A detailed and comprehensive ascertainment of demands or uses of the interconnection system;

3) A thorough exploration of the legal issues involved, including a determination of what steps under state law might be necessary to implement public ownership and funding of any of the interconnection entities; and

4) A program to closely monitor developments on the federal level, as they affect the licensing of various microwave facilities and, on a local level, of the franchising activity by the municipalities in the seven-county area.

The informational and educational program is necessary to develop interest and support among potential users. Relevant portions of this study should be distributed to government entities, educational and cultural institutions and citizen groups across the area. The difficulty in directing public attention to the idea of interconnection has been partially due to the absence of any tangible examples of what interconnection systems are and how they would function across a number of political jurisdictions. Hopefully, this study has bridged that gap and will be used as a public informational tool.

The ascertainment of potential users and communications projects is a most important aspect of this long-range planning effort. It alone might take nine to twelve months. As indicated in Chapter III, the uses assumed for purposes of this report were made on the basis of a relatively brief solicitation process. One of the most frequent comments to the center from

members of the Interconnection Subcommittee was that considerably more time was necessary to inform the public about interconnection generally and about its possibilities for use in the regional area, and to implement a concerted and well-organized use ascertainment program reaching all elements of the community.

Furthermore, the council will be able to conduct a more realistic and comprehensive use survey. As indicated in Chapter V, cost estimates for using different portions of the various interconnection systems designed here have been computed. Further, these costs are, in many cases, considerably lower than can currently be provided by other common carriers. Hopefully, potential users across the metropolitan area can now make better, more realistic predictions of use, since they have an understanding of: 1) What the prices for various services might be; and 2) Cost savings when compared with the tariffs offered by other common carriers.

The third aspect of this long range plan is to examine the legal issues that may arise with respect to any of the interconnection system options. Whether a publicly owned interconnection system is a "person" within the meaning of the Communications Act of 1934 and therefore subject to FCC common carrier rules is one of the more important questions which needs to be examined. The best method of analyzing this question would be to raise it as soon as possible to the FCC, and to begin discussing its resolution with the commission's staff. Another important legal issue is whether a regional interconnection system can be publicly financed, and if so, how. This

question must be considered early in the council's planning process since special legislation may be required in order to allow a public entity to own and finance an interconnection system.

The final step in this first stage of the long-range planning process is the monitoring of related federal and local developments. It is essential to keep close track of the status of operating or planned cable systems in the metropolitan area. Additionally, it is essential that the council be apprised of the communications licensing requests made by area cable systems and other institutions. For example, in order to keep Option III open, it is necessary that the LDS license for the area either be kept available or, in the alternative, be accessible for potential public use. By requiring all local municipalities to receive copies of any applications made to the FCC by cable operators for the LDS license and informing the council of such action, the council will be able to file comments at the FCC concerning the award of any LDS license. From the local perspective, it is essential that the council know when local municipalities or groups of municipalities are in the process of franchising cable systems. By being aware of municipalities' plans, it is possible that the council will be able to urge these franchising authorities to incorporate provisions in their franchises which would allow for interconnection at each of the levels described in Chapter IV.

After the informational phase, the ascertainment of uses phase and the legal survey, the council should make an interim evaluation of the prospects for interconnection in the area. At that time, it will be able to gauge the

level of interest and, therefore, the demand for interconnection services. Moreover, the council will have a better notion of what legal and regulatory steps must be taken in order to effectuate various ownership and financing options. Additionally, the availability of appropriate management firms to operate a publicly owned interconnection system will be better known. Finally, the council will be able to determine then how quickly cable system development in the area is going to take place. With this information, the council can formulate questions about interconnection service, ownership, financing and regulation which can then be presented to the public, governmental entities and other institutions across the area in a series of public hearings.

Also, during this period of interim evaluation, the council can undertake more engineering and financial analysis. For example, suppose the more thorough ascertainment process were to reveal that if prices were lower, there would be a much greater interest in using the interconnection system for data communications than was anticipated in the use assumptions of this report. A new tariff based upon the increased demand could be calculated then and offered to potential users later, at the time of contracting for the initial uses of the system. There are a host of other pricing issues and engineering questions which can be tested at this stage, after the comprehensive uses survey.

The council will then be ready to hold public hearings on the issues it has formulated during the interim evaluative phase. The hearings should consider policy questions such as how the project would be financed and

regulated--the principal questions that warrant public comment.

Finally, after these sessions, the council will be able to make firm decisions on the level of service needed, and the form of ownership, financing and management. The actual implementation process should begin with the development of engineering blueprints and the execution of contracts for the financing, management and use of the system.

The following is a procedural checklist which summarizes the procedure the council should follow:

1. Informational and educational program on interconnection for government entities, educational, cultural and other institutions, and the general public.

2. Detailed and thorough ascertainment of users and communications projects.

3. Intensive survey of legal issues affecting interconnection.

4. Continual monitoring of both federal licensing of microwave facilities in the area and cable TV franchising actions of local governments.

After the first three tasks are effected, the council should:

5. Have additional engineering and financial analysis performed, based upon results of thorough uses ascertainment process.

6. Formulate issues about interconnection the council wants publicly debated.

7. Hold public hearings, discussing these questions.

8. Make series of decisions about actions to be taken and recommended.

INTERIM DECISIONS AND ACTIONS

The second function that the Metro Council should perform is less involved with planning and more related to preserving the options presented in Chapters IV and V. For example, a legitimate question to ask after this analytical material and long long-range plan has been presented and proposed is, "What action should the council take in the event that a local franchising authority determines to franchise a cable television system before the council can complete the long-range process described above?"

The council's interest in this question is to assure that the options it is considering for interconnection remain open while its long-term plan is being carried out. It should also be interested in avoiding any significant delay of the areawide cable system franchising process. To satisfy both of these goals, the council should urge local governments which wish to franchise to adopt ordinance provisions and franchise terms which are sufficiently flexible to allow for the system to be part of any regional interconnection system, but precise enough to enforce. An example of such a provision is the following:

> The cable television system shall be constructed in a manner that will permit it to function compatibly with any of the five (5) Interconnection System Options described in Planning Interconnection Systems: Options for the Twin Cities Metropolitan Area, a report prepared by the Cable Television Information Center for the Metropolitan Council of the Twin Cities Area, dated June 13, 1974. This provision shall be effective until (projected completion date of planning process).

Inclusion of this type of provision may be the best way to ensure that local municipalities which franchise cable systems over the near term are

guaranteed the services made available by interconnection.

A second short-term goal of the council should be to assure that each of the engineering option prototypes remains viable. As was mentioned earlier in this chapter, this involves a close monitoring of both the applications for LDS and ITFS licenses, but expecially the former. Since there can generally be only one LDS license in a specific geographic area, securing this license for the use of local cable systems only could inhibit the development of at least system Option III. It may be impossible to block the issuance of an LDS license for the area. At the very least, then, the council should develop a method of learning if the license is being applied for. This could be done by having local municipalities which have franchised or are franchising cable systems to include an ordinance provision which requires their cable operators to notify the city, and supply copies of any applications for LDS. Or, the council could immediately ask that the FCC inform it of any request for an LDS license. Being aware of any applications would allow the council to raise its interconnection plans with the commission. Again, while this might not prevent licensing, it could perhaps ensure that the microwave system would provide planned public services to cable headends.

The ITFS case is much less of a problem since a large number of channels are made available. And in the Twin Cities area, only six of these 28 channels have been licensed. However, it is still in the council's interest to know of applications for these licenses. This could be done by contacting all school systems and governmental units in the area and requesting information on ITFS licensing or by asking the FCC for information about applications in

this area as they are made.

CONCLUSION

This study represents the results of eight months of discussions, analysis, research and reasoning. It is also the end product of the first comprehensive study of the regional interconnection of cable television systems. The engineering prototypes and service tariffs reflect the center's attempts to meet hypothetical, though specific, communications needs as presented to it by persons, institutions and governments in the Twin Cities area. The study also explores the roles a public agency can fulfill in communications planning beyond simple franchising. But this study must be only the first step of many. Some of these steps have been charted in this chapter. The council will undoubtedly discover some which have not yet been considered. The Cable Television Information Center is available to the Metropolitan Council of the Twin Cities Area to assist in the implementation of this study.

GLOSSARY

ALPHANUMERIC KEYBOARD: Device for keying the generation of letters and numbers, for instance a typewriter or teletypewriter.

ARTERIES: See Trunk or Trunk Arteries (below).

AUDIO RESPONSE: In two-way communications, the capacity or ability of a number of subordinate places to "speak" back to the central location. Also called "voiceback."

BANDWIDTH: A measure of spectrum (frequency) use or capacity. For instance a voice transmission by telephone requires a bandwidth of about 3,000 hertz (cycles per second) or three kilohertz (KHz). A TV channel occupie a bandwidth of six million hertz or six megahertz (MHz).

BROADBAND: A general term used to describe equipment or systems which can carry a wide range of frequencies or channels.

CABLECASTING: All television programming originated on a cable system as distinguished from the retransmission of over-the-air broadcast signals.

CLOSED CIRCUIT USE: Any transmission method by which reception is not available to the general public. The receiving equipment (often special apparatus not generally available) is directly linked to the originating equipment by cable, microwave relay or telephone links Closed circuit television is designed to be beamed within a given area that is usually much smaller than a network or local station's territory. Extensively used for monitoring in hospitals, police stations, prisons, etc.

COMMON CARRIER MICROWAVE: Microwave service available to cable television and others at published tariff rates approved by the Federal Communications Commission.

COMMUNITY INFORMATION AND SERVICE CENTER (CISC): Center which would provide a central point linking the public to local government and public service agencies via two-way communications systems, equipped with interactive terminals and video telephone.

CISC COMPANY: A public entity which would own the CISC's and the CISC computer control facilities at the master control center, and which would rent from an interconnection network the channels needed to interconnect the CISC's.

CISC NETWORK COMPANY: Entity that owns the cable system that interconnects the various CISC's.

COMPUTER ASSISTED INSTRUCTION: Use of computer as a medium to present instruction directly to the student; computer assists or substitutes for instructor.

DEDICATED CHANNEL: A channel (in use or available on demand) solely devoted to a particular type of purpose or service, i.e., education, police, meter reading, library, etc.

DIRECTIONAL ANTENNA: An antenna having the property of radiating or receiving radio waves more effectively in some directions than others.

DISTANT SIGNALS: TV signals which originate at a point too far away to be picked up by ordinary home reception equipment. Signals, defined by the Federal Communications Commission as outside a broadcaster's license area, which are picked up and imported into the community served by the cable system.

DISTRIBUTION SYSTEM: The equipment needed to carry signals from the headend to the subscriber. This includes amplifiers, trunk and feeder cable, subscriber taps, drop cable and assorted equipment.

DOWNCONVERTER: Used to convert ITFS microwave frequencies to VHF.

DOWNSTREAM: Signals traveling from the headend to subscribers.

DUAL CABLE: A method of doubling channel capacity by using two cables installed side by side to carry different signals.

ELECTRONICS: That field of science and engineering that deals with electronic devices and their utilization.

"EXPRESS COUNTER": Terminal by which user can browse through still video pictures displayed on a black and white television monitor, controlled by a small keyboard used in search for visual information such as airplane schedules and theater ticket availability.

HARDWARE: The equipment involved in production, storage, distribution or reception of electronic signals. In cable usage, it means the headend, coaxial cable network, amplifiers, television receiver and production equipment such as cameras and videotape recorders.

HEADEND: Electronic control center generally located at the antenna site of a cable television system, usually including antennas, preamplifiers, frequency converters, demodulators, modulators and other related equipment which amplify, filter and convert incoming broadcast TV signals to cable system channels.

HOME (SUBSCRIBER) TERMINAL: The connectors, transformers, dual cable switch and/or converter interfacing the cable system with the subscriber's television set. The term usually refers to the additional equipment required in the subscriber's home for two-way service.

HUB: A central point from which signals are distributed over a cable system. Large areas may require more than one hub for adequate service.

INTERACTIVE TELEVISION: A system that allows two-way communications, with each part of the system affecting the others.

INTERCONNECTION PRICES: The charges assessed for use of channel capacity in the various interconnection options.

LOCAL DISTRIBUTION SERVICE (LDS): A fixed microwave relay station used within a cable television system or systems for the transmission of television signals and related audio signals, signals of standard and FM broadcasters, signals of instructional television fixed stations and cablecasting from a local transmission point to one or more receiving points, from which the signals are distributed to the public by cable.

MASTER CONTROL CENTER: Central base for control of information exchange in CISC network. Includes switching facilities for control of video phone service, and computer-based system which controls information display and access to express counters and interactive terminals for all CISC's.

MASTER SWITCHING CENTER: Provides means of mixing together various programming from CISC's (video and audio) and delivering it to other CISC's. Includes special effects generator.

MICROWAVE OR MICROWAVE TRANSMISSION: Line of sight, point-to-point transmission of signals well above the normal frequencies of TV channels on cable systems. Microwave is used for the importation of distant television signals and local signal distribution.

OMNIDIRECTIONAL ANTENNA: An antenna having an essentially nondirectional pattern in azimuth and a directional pattern in elevation.

ORIGINATION: Programming carried on a cable system over one or more channels and subject to the exclusive control of the cable operator.

PARABOLIC ANTENNA: An antenna that has a folded dipole or feed horn mounted at the focal point of a metal or mesh dish having a concave shape known as a parabola.

"PARTY-LINE" CHANNEL (use): A subscriber line arranged to serve more than one main station.

POINT-TO-POINT (closed circuit): When used in reference to cable systems, an arrangement which permits a limited number of users to be interconnected by private channels.

RECEIVER: The apparatus employed to receive aural and/or visual signals, e.g., a radio or TV set.

SATELLITE GROUND RECEIVER: Provides link with national satellite networks.

SPECIAL EFFECTS GENERATOR: A device permitting combinations of images on a television screen supplied by one or more video inputs.

SOFTWARE: The programs which "tell" a computer how to perform a specific function, for example, controlling a subscriber response system. The term is also used to indicate the programming and programming materials used in television presentations such as films, videotapes and slides.

SUBSCRIBER RESPONSE SYSTEM: A two-way cable facility which allows subscribers with the proper home terminal equipment to respond to queries presented from the headend. Subscribers, for example, might vote for or against proposals being discussed on a panel show.

SWITCHED FACILITIES: A cable communications service in which each subscriber has a terminal and may communicate with any otner subscriber.

TELECONFERENCE: A process used for interactive instruction such as high school debates and local government meetings where audience response is an important element.

TERMINAL: The connectors, transformers and converter (if necessary) on the cable subscriber's set.

TICCIT (Time Shared Interactive Computer Controlled Informational Television): An interactive television system which allows each participant to receive, on demand, a series of individual frames of information on a TV set.

TIME-SHARED CHANNEL: Time segments on a dedicated channel shared by various groups such as schools, libraries and police stations, rather than a separate channel designated for each particular use.

TRANSMITTER: The apparatus employed to transmit aural and/or visual signals.

TRUNK OR TRUNK ARTERIES OR ARTERIES: The backbone or main line of the cable television system. This main coaxial cable carries signals from the headend or central hub to the extremities of the area served with the minimum possible number of amplifiers. Also, trunk line--the major distribution cable used in cable television. It branches into feeder lines which are tapped for service to subscribers.

UPSTREAM: Signals traveling from subscribers to the headend.

VIDEO TELEPHONE: A private two-way video and audio transmission between CISC's.

WAVEGUIDE: Usually a hollow metal tube dielectric cylinder of such dimensions that it will propagate electromagnatic waves of a given frequency used for transmitting super high frequency waves or microwaves.